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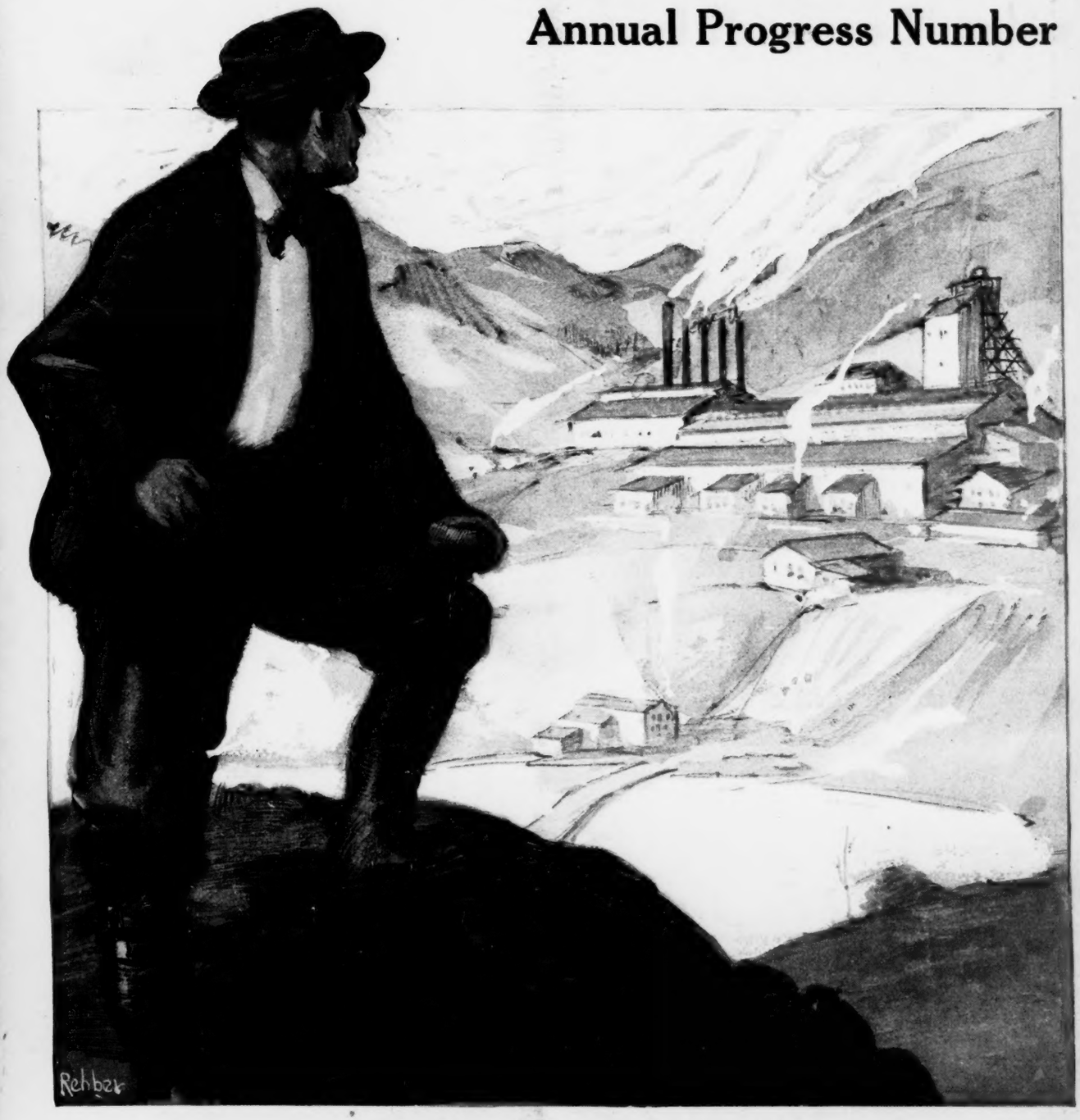


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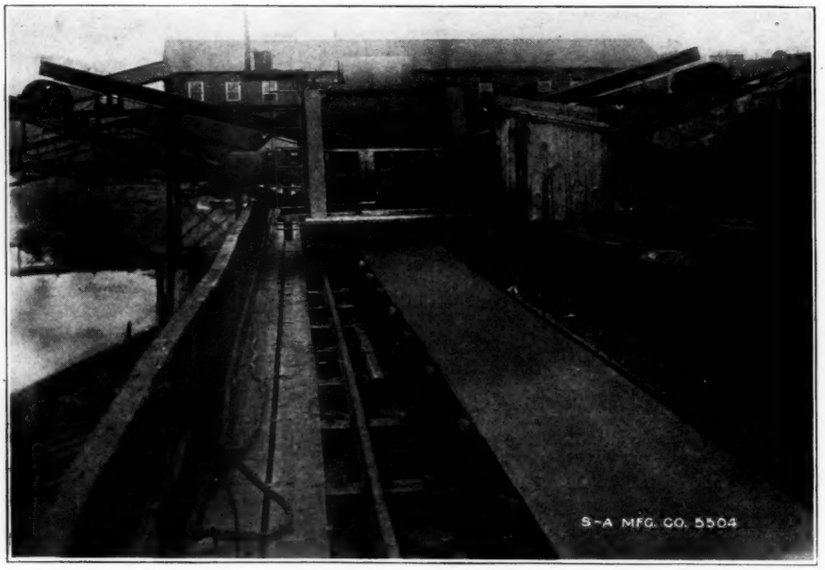
—*Josiah Edward Spurr*

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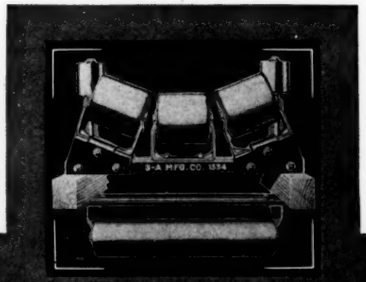

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# Annual Progress Number

## Industrial Analysis

## Copper in 1921

By H. A. C. Jenison*
Geologist in charge of Copper, U. S. Geological Survey

THE FUTURE OF THE COPPER INDUSTRY is influenced by many unmeasured factors. Certain world-wide tendencies are evident, but the effect of such tendencies in individual countries is obscure. A revival of the domestic industry during the first half of 1922 is expected by some, but is mainly dependent upon general business revival here and in Europe.

Recently much has been said about new uses for copper, the increased electrification and the return of copper to its old place in the building industry and the household, but, because of the time necessary for the development of these uses, it appears that in the immediate future the consumption of copper will be almost entirely limited to the present fields.

Despite the low price of copper, exports of copper and its manufactures in 1921, including those to Japan, probably will not have exceeded 650,000,000 lb., which is considerably below the annual exports from 1907 to 1913. Germany was our largest pre-war customer, but her buying power is now greatly restricted and will probably continue to be for some time. It therefore appears unlikely that the export market will greatly improve for some time.

In considering the capacities of domestic and foreign markets, the relation of present domestic productive capacity to potential consumption is of interest. At the pre-war rate of increase, normal domestic consumption in 1922 should be about 1,100,000,000 lb., and from the present outlook it is unlikely that this figure will be exceeded.

The present productive capacity of domestic mines is at least 2,000,000,000 lb., and the refinery capacity at least 2,500,000,000 lb. The excess of refinery capacity is for copper from foreign mines which are likely to operate at as full capacity as the domestic mines. If mines and refineries operate at full capacity in 1922 or 1923, about 1,400,000,000 lb. will be available for export—more than our foreign markets are likely to absorb annually for a long time to come. It appears, therefore, that revival of the domestic mining and metallurgical industry will be gradual.

The more distant future of the industry is obscure. The domestic market apparently has many possibilities, among which is the creation of new uses for copper. The campaign conducted for this purpose already appears to be meeting with slight success, and may accomplish more than is now considered possible. In household uses copper is apparently meeting with a worthy rival in Monel metal, which, from all that can be learned, may prove to be more suitable for such uses than copper or aluminum, and can compete in price with either. The ultimate economy of copper roofing does not yet appear to have enthused the majority of builders and no great increase in the use of copper roofing in competition with other roofing materials is to be expected under existing conditions.

Electrification of railroads is considered one of the greatest future uses of copper. According to past experience, 10,000 lb. of copper used per mile of single track electrified is a very liberal estimate; in fact 6,000 lb. per mile is probably closer to the real consumption. For one mile of double track much less is required than for two miles of single track. Power plants, substations, transmission lines, and other equipment necessary to furnish power for electrified roads are estimated to require less than 10,000 lb. per mile of track electrified, and some of the lines most favorably situated for electrification would require less than those upon which the estimate is made. Even assuming electrification for the next decade at the rate of 20,000 lb. per mile and 4,000 miles per annum (two liberal assumptions), the maximum total requirements of copper would not exceed 80,000,000 lb. per year.

Electrical engineers of the Superpower Survey of the U. S. Geological Survey estimate that the amount and rate of copper consumption in the electrification of

*Published by permission of the Director, U. S. Geological Survey.

factories and railways in the "superpower zone" will be such as to have little or no effect upon the market price of the metal. Hydro-electrical development will consume considerable copper, but will be gradual, and the replacement rate in electrical apparatus is low.

It seems that the plumbing and small-hardware industry offers the best field for increased domestic consumption, and the replacement rate in such a field would probably be higher than in most others. In this connection a most hopeful feature is the campaign against unreasonable retail prices and the disposition of large producers to enter the fabricating industry. Reduction of cost to the ultimate consumer will probably do more toward increasing domestic consumption than any other thing. The experience of certain steel companies is a notable case in point.

Another promising field for increasing domestic consumption is in the electrification of tools. Individual tools and machines driven by individual electric motors are far more economical and satisfactory than a number of tools or machines driven from a single shaft. Electrification of auxiliary machinery in plants now operated by steam prime-movers also appears promising.

### Future Export Market

The export market after the next two or three years is also uncertain. The questions of exchange and the rehabilitation of European industry are apparently only part of the problem. Though Germany's buying power is now limited, it is believed by some that her replacement needs will offer a great market for domestic copper. Much of Germany's apparent pre-war consumption, however, was merely a scheme for the creation of great reserves by inducing the consumption of copper in such forms as to be readily available for war purposes. Copper was consumed in Germany in the decorating and covering of shop fronts and in a variety of other unnecessary uses which probably will never be renewed in Germany or in any other country suffering from the war while cheaper material can be obtained. The electrical industry of Europe, as in other regions, will probably recover and expand slowly.

Foreign competition for the European market within the next decade may well be considered. The Chile Copper Company is reported upon good authority to be planning enormous increases in ore treated. The first increase is to raise the capacity to about 27,000 tons of ore per day, or more than 300,000,000 lb. of copper per annum. The second will raise it to 40,000 tons per day and the third to 50,000 tons per day. A large plant for the treatment of ores which do not leach readily is also contemplated. Plans and specifications are supposed to be complete for the plant of 40,000-ton capacity, but progress on it has been delayed on account of high costs. With this increased capacity, the company should have available for European market within the next decade about 500,000,000 to 600,000,000 lb. of electrolytic copper at a relatively low cost.

The Union Minière du Haut Katanga has recently started the construction of a 4,000-ton concentrating plant for ores not amenable to leaching and of too low grade for direct smelting, and a leaching plant reported capable of producing 110,000,000 lb. of copper per annum. Both installations are reported to be the initial units of a much larger plant. The company is also undertaking development of sufficient hydro-electric power for the refining of all copper produced. At this rate the company should produce in the near future about 200,000,000 lb. of refined copper, available for the European market at a low cost, and it is probable that within a few years the company's production may be increased to about 400,000,000 lb. per annum. These two great companies, if their planned output is realized, should, together with the Spanish producers, make from 800,000,000 to 1,100,000,000 lb. of copper per annum, available to the European market at a price with which competition will be difficult.

With allowance for the increased output of these producers, productive capacity within the next decade should be nearly 4,000,000,000 lb., of which about 2,000,000,000 to 2,500,000,000 lb. will be available to the European market, a large part of which may be at a cost with which producers in the United States cannot easily compete. In short, both the slow recovery of the European market and the growing competition for it are possibilities that our producers must bear in mind in planning for the future.

The smelter production of copper from domestic ore in 1921 based upon actual figures for the first eleven months and estimates for December was about 461,000,000 lb. The refinery production on the same basis was about 601,000,000 lb. from domestic sources and about 320,000,000 lb. from foreign sources.

According to the records of the Department of Commerce, total imports for the first eleven months of copper, in ore, concentrates, matte, blister, and refined copper, were about 318,000,000 lb., of which 68,000,000 lb. was refined copper and 157,000,000 was blister copper. Exports for eleven months totaled about 567,000,000 lb., of which about 538,000,000 lb. was new refined copper and 29,000,000 lb. was manufactured.

The total supply of new refined copper for the year was about 989,000,000 lb., which includes refinery production from foreign and domestic sources and refined copper imported. The stocks of refined copper in hands of domestic refineries Dec. 31, 1921, excluding those in transit, were about 496,000,000 lb. Stocks of blister on that date in hands of smelters, in transit to refineries, and in hands of refineries, including materials in process, were about 297,000,000 lb. The amount of new refined copper withdrawn upon domestic account for 1921 was about 614,000,000 lb., as given in Table I.

TABLE I.—PRODUCTION, STOCKS, IMPORTS, EXPORTS, AND CONSUMPTION OF COPPER, 1919-1921.

| | In Pounds 1919 | 1920 | 1921 |
|---|---|---|---|
| Smelter output from domestic ores | 1,286,000,000 | 1,209,000,000 | 461,000,000 |
| Refinery production of new copper from domestic and foreign ores | 1,768,000,000 | 1,635,000,000 | 921,000,000 |
| Stocks at the end of the year, at smelters and refineries | 904,000,000 | 1,125,000,000 | (a) 783,000,000 |
| Imports | 429,387,594 | 486,000,000 | (b) 68,000,000 |
| Exports | 516,627,775 | 623,000,000 | (b) 538,000,000 |
| Apparent domestic consumption | 877,000,000 | 1,053,000,000 | (c) 614,000,000 |

(a) Amount contains 496,000,000 lb. of refined copper and 297,000,000 lb. of blister copper. (b) Total for eleven months ending Nov. 30, 1921, from records of the Bureau of Foreign and Domestic Commerce. (c) Estimated.

TABLE II.—MONTHLY AVERAGE PRICE OF COPPER

| | New York — Electrolytic | | London — Standard | | London — Electrolytic | |
|---|---|---|---|---|---|---|
| Month | 1920 | 1921 | 1920 | 1921 | 1920 | 1921 |
| January | 18.918 | 12.597 | 118.095 | 70.964 | 123.238 | 79.119 |
| February | 18.569 | 12.556 | 120.188 | 70.925 | 126.950 | 75.925 |
| March | 18.331 | 11.976 | 109.533 | 67.565 | 118.348 | 71.190 |
| April | 18.660 | 12.438 | 103.025 | 69.381 | 111.500 | 71.786 |
| May | 18.484 | 12.742 | 96.750 | 73.196 | 109.200 | 74.298 |
| June | 18.065 | 12.697 | 87.864 | 71.852 | 101.909 | 75.682 |
| July | 18.576 | 12.170 | 90.148 | 71.155 | 106.455 | 75.286 |
| August | 18.346 | 11.634 | 93.935 | 68.614 | 111.143 | 72.705 |
| September | 18.144 | 11.948 | 96.381 | 67.977 | 111.905 | 72.295 |
| October | 15.934 | 12.673 | 93.327 | 67.327 | 104.905 | 73.476 |
| November | 14.257 | 13.035 | 84.807 | 66.614 | 94.614 | 74.386 |
| December | 13.188 | 13.555 | 75.702 | 66.706 | 85.905 | 74.525 |
| Year | 17.456 | 12.502 | 97.480 | 69.356 | 108.839 | 74.223 |

New York quotations, cents per lb. London, pounds sterling per long ton.

# Lead Mining

BY CLINTON H. CRANE
President, St. Joseph Lead Co.

CONDITIONS DURING 1921 in the lead-mining industry, particularly in the United States, were most discouraging. The selling price of the metal had returned to the pre-war level, but costs, certainly at the beginning of the year, were still on the war level. Mining, milling, and smelting costs had more than doubled since 1914; wages had increased in no districts less than 75 per cent, and in many operations over 100 per cent; efficiency had dropped; materials, supplies, and railroad freights had in general more than doubled, and on some roads quadrupled. Unless costs could be brought down, most of the ore in the United States would cease to be ore in the generally accepted sense.

Wages, representing in most enterprises about half the total cost of production, could be reduced. In well-established camps wage reductions were welcomed as an alternative to a complete shutdown, but wages could not be reduced anywhere to the pre-war level, for the cost of living had not returned to that level, and in the mining districts still remained at from 25 to 40 per cent above the pre-war scale.

Materials, in the order of their importance, coal, coke, powder, steel, and general supplies, were subject to the law of supply and demand, and some reductions took place as business slackened. In general, for lead-mining districts having no water power, by the end of 1921 coal under the boilers was costing from 50 to 80 per cent of what it did at the end of 1920, but still at least double the 1913 price. For various localities, at the end of 1921, the cost of coke was from 65 to 100 per cent of that at the end of 1920; the cost of powder ranged from 90 to 95 per cent, and that of drill steel from 80 to 90 per cent; but in each of these items the costs were still much higher than in 1913.

Despite reductions in wages and materials, it is probable that the cost of producing ore is still 40 to 60 per cent higher than it was before the war, and the cost of producing lead from ore of the same grade has increased in like proportion. Only the lower-cost producers can exist under the present conditions, and these low-cost producers must sacrifice their high-grade deposits to live at all.

The increase in freight rates effective June 25, 1918, and a further increase on Aug. 26, 1920, have very greatly affected the cost of everything in the country, but the mining industry has been especially penalized. Although general rates in June, 1918, were increased only 25 per cent, the average increase on all mine and smelter products was 55 per cent. This, together with the advance in August, 1920, raised freight on these products by more than 110 per cent. These freight increases have magnified the differentials between properties in different parts of the country and have opened to foreign competition, on the Atlantic seaboard, markets which otherwise would have been closed.

No new metallurgical or mechanical improvements have recently been developed. Without flotation many mines that are operating today would be shut down. Flotation in milling and the one-man drill in mining had already come to the help of the industry just before the war started. Excepting extensions of known ore areas in the Tri-State district, no new deposits of lead were discovered in 1921, and with the present conditions there is no inducement for intensive exploration.

The United States lead-mining industry has developed to its present proportions with the help of protective tariffs, under which enough lead has been produced to supply domestic needs, with no surplus for export. Thus, there has been no foreign market for it to lose. Correspondingly, except in boom times or under inadequate and irrational tariffs such as that now in force, there has been no room for imports; but during the last two years so much foreign lead has been imported that many American mines are closed down; and unless the country's usual tariff policy is resumed they will remain closed down to make place for the more cheaply produced metal of Mexico and Spain.

The outlook for 1922 in the lead-mining industry is much brighter than it was at the beginning of 1921. Most districts have held their working forces intact and have returned to a pre-war efficiency. The early enactment of an adequate specific tariff is anticipated. Furthermore, certain reductions in freight rates on bullion and refined metal have recently been made.

With a revival of business, particularly in the building industries, more lead should be needed, but unless costs can be still further lowered, largely by additional reductions in freights and in the cost of important raw materials, a larger volume of lead can be produced only at higher price levels.

# Zinc Mining

BY ARTHUR THACHER
Mining Engineer, St. Louis, Mo.

THE year 1921 was most disastrous to the zinc miners. The effects of the war produced a financial crisis which required a drastic curtailment of all expenditures and brought about a hand-to-mouth rate of expenditure extremely detrimental to the industry and to general prosperity and well-being, which involves providing for future as well as present requirements. As a result, the consumer used all his supply before purchasing, while the dealer waited till his stock was exhausted before ordering. This increased the stocks at the smelters, as they were carrying what would ordinarily be in the hands of the dealer and consumers. The smelters in turn diminished their ore stocks, thus increasing the ore stocks in the hands of the miner. The miner had no one to pass his stock on to, and his only relief was to curtail or stop mining.

With most of the mines closed and in financial trouble there has been only the average improvement in methods

and equipment. Some improvement is always taking place. Perhaps one exception can be noted in the use of underground loading machines. In common with all advances and improvements in practice, the introduction of machine loaders is making slow headway and has not yet, on the whole, afforded the zinc miner radically cheaper mining costs. The field looks promising, but the miners of zinc must be patient before expecting any great change in their cost sheets.

The great change that is now taking place is a mental one. The war was fought on autocracy, which is only another name for peonage. The peonage idea has existed since the beginning of history, and has only been slowly dying. The war marks only one victory, but a great one. Real civilization consists of co-operation and the square deal. The war aroused mental activity and encouraged thought in the right direction. The first efforts naturally resulted in chaotic conditions, but this is passing, and the world is coming into a new and greater era. We are prone to overlook this human factor and attribute success to natural resources, science, and machinery. No doubt these are great factors, but without intelligent co-operative human effort they bring little results.

Though 1921 was a year of discouragement and despair to the zinc miner, this is only a temporary condition, and we can look forward to a future which will make the past look small.

As indicated before, the world has been living on its accumulation, the real consumption being greater than we realize. There is no reason to believe that larger stocks than were necessary were being carried before the war, and therefore with the return to steady conditions we will find that the stocks at the mines and smelters, large as they now appear, are insufficient to build up to the supply carried in pre-war days.

With respect to the future demand for zinc, it is to be noted that this country has been an active producer for about fifty years and that the production has more than doubled every ten years; the last doubling being in about nine years. If it is objected that the war caused this in the last nine years, we only have to take the preceding years. Moreover, this condition is confirmed by world figures and the figures on iron, steel, copper, and lead, although the figures for the doubling vary from nine up to fifteen years or more. It is immaterial in this connection just what the number of years are. The important point is that in less than fifteen years, probably in not over ten years, the world will call for double the present average output and a total of more zinc than the world has so far produced. This can and will be supplied by better operation and at a higher price, which will enable us to work lower-grade material that is now not even classed as ore. This is the history of the past.

It may be urged that increase of price would curtail consumption. This is true of most finished articles, but is not strictly true in relation to the ore or crude metals. To the ultimate user who finally pays the bill the total cost of the ore, or even the crude metal, is not over 5 per cent of what he pays, and even a doubling of the original cost of the ore would not make any great difference to him.

The world is in a metal age, and the twentieth century has already used more metals than were produced in all preceding time. The results are inevitable, but how rapidly they will come depends on man. The great controlling factor is co-operation, or combining efforts, and the accomplishment of this depends on the mining engineer.

In the past the labor problem has loomed large, but that has been principally because we viewed it from the side of peonage and its attendant side lines, and with a truer realization of co-operation and the square deal the labor situation will change and the results will constantly improve, as they have in the past.

We have had only one generation of civilization developed on metals, and with this start and our increased knowledge, coupled with the war victory, the coming twenty-five years will show remarkable advance.

# Gold Mining

By Sidney J. Jennings
Vice-president, United States Smelting, Refining & Mining Co., New York

A STUDY of a table of statistics showing the output of gold by countries for the last year indicates as an outstanding fact that 67 per cent of the output came from those constituting the British Empire. The cost of labor, materials and transportation necessary to produce this gold was paid for in the depreciated paper currency of the different countries forming that commonwealth of states and dominions.

The premium that gold commanded varied not only from country to country but also from month to month, and it is impracticable at this time to say what the weighted average premium was. The maximum was somewhere near 50 per cent in the Transvaal and the minimum about 10 per cent in Canada. The United States, which produced 14 per cent of the gold, and Mexico, which produced 4 per cent, did not have this advantage. This premium on gold will disappear as the rates of exchange between the United States and the different countries of the British Empire return to a normal basis. The recent rapid rise in the value of the pound sterling expressed in terms of United States dollars shows that the length of time before this occurs may be shorter than many expect.

The leaders of the gold-mining industry in the Transvaal, which is producing about 48 per cent of the world's supply of gold, constantly point out in their reports and speeches the fact that the continued operation of a number of so-called "low-grade mines" is entirely dependent upon the premium received for their gold. If this premium disappears, as apparently it may do in a short time, one of two things will have to happen. Either the wages of the laborers in the gold mines and the cost of supplies will have to be materially reduced or else these mines must close down. An analysis of the cost of producing gold at certain of the mines in the Transvaal shows that, even with any reduction that is within reasonable probability in wages and cost of supplies, some of them are unable to produce gold except at a loss, and these will undoubtedly be compelled to discontinue.

In addition to the before-mentioned factors, several mines on the Rand are reaching the end of their ore reserves, and will in consequence cease producing. The new mines that are being developed on the Far Eastern Rand cannot produce enough gold to make up for the losses occasioned by the factor mentioned. It therefore

seems fairly certain that the Transvaal has reached the apogee of its gold production and will continue at even a more rapid rate the decline which has been taking place in the last few years.

### Production of Australasia, Canada and India Likely to Decline

The production of gold in Australasia has shown a steady decrease, and no new production looms up on the horizon of sufficient importance to stay this decline.

The production in Canada and India has been maintained, but in both countries the producing mines are reaching increasing depth and no new large ones are being opened. It seems inevitable that a decrease in gold production in these two countries must take place, in the cost of supplies and labor which took place during may hold out surprises in the direction of new production.

In the United States the decline in the production of gold continued throughout 1921. The small reduction in the cost of supplies and labor which took place during 1921 was not sufficient to warrant starting up many of those properties that were closed down during the peak of the rise in price. The production of gold in the United States has also been diminished by the closing down of the copper mines, from which a certain amount of gold was produced as a byproduct.

### Hope Lies in Alaska

In Alaska, the exhaustion of the old placer deposits, without the discovery of new ones of magnitude, has brought about a diminished production. The mines at Douglas Island have not been reopened after the disaster which overtook them some years ago, and the poor success of the mines on the mainland, where the anticipated expectations have not as yet been achieved, also brought about a decrease in production. There is, however, considerably more interest being shown in gold mining at the present time, and when the anticipated reductions in freight rates, cost of coal, powder and steel and reduced wages, become a fact, a slow resumption of gold mining will undoubtedly take place, which may be in sufficient volume not only to arrest the decline in production in the United States but to increase production.

The decline in production of gold in Russia has been due to political causes, and until a stable form of government is established, and one more conducive to fostering the production of wealth, the resumption of gold mining on any large scale will not take place in that vast territory.

This rapid survey of the chief gold-producing countries shows that on balance the production of gold will decline in the immediate future. No epoch-making metallurgical discoveries have taken place, nor has any new method of mining been devised which will bring into the realm of commercial ore, material, which though gold-bearing, has not a sufficiently high content to warrant its exploitation.

### Need of Gold as a Currency Basis

The demand for gold or some metallic currency which will provide a sound money for the peoples of Central Europe and Russia is going to increase enormously. It is difficult to say at what point a paper currency becomes worthless as a medium of exchange, but it seems probable that this point will be reached in a comparatively short time by the currencies of Central Europe and Russia. No matter how patient or obedient to their governments peoples may be, the time will come, as it did in France in the time of the Revolution, and as it did in Mexico four years ago, when the workmen will say, "I will not work and be paid in a medium the value of which decreases 10 per cent a week."

Experience proves that when a people once discards the use of an inconvertible paper currency, that people will not return to paper money, however well secured, as long as the governments are run by those who have caused suffering by the ruin and misery brought on by an inconvertible paper money.

When once started, the power of these European countries to absorb gold or silver or both will be great and increasing. The price of their products measured in the terms of these metals will be small and decreasing, and it very well may be that the value of gold measured in terms of commodities will be so great that material which is now looked upon as worthless rock, though gold-bearing, can be worked at a profit. It is possible that the financial experts of these countries may perceive this tendency and seek to counteract it by the use in some measure of silver as a circulating medium. This use of silver will tend to stabilize prices, a consummation much to be desired in every community.

Whether silver is used as a circulating medium or not, the demand for gold will increase greatly in the not distant future, and with this increased demand for gold will come an increased interest in and more active search for gold mines.

# Silver Mining

By Felix Edgar Wormser
Assistant Editor, *Engineering and Mining Journal*

AMERICAN SILVER PRODUCERS were little concerned in the fluctuations of the silver market in 1921, for they received a fixed price for their product under the provisions of the Pittman Act. This price, fixed by law at $1 per oz., varied within a fraction of a cent of that amount, depending upon the delivery point for the metal, whether the Denver, San Francisco, or Philadelphia mint. About 58,563,000 oz. was bought by the Government during the year, bringing total purchases to 88,570,000 oz. since May 13, 1920. A further amount of 119,430,000 oz. remains to be purchased, which will require about two more years. The closing of the copper mines and the depression in lead and zinc has not had the effect anticipated upon production—estimated to have been 50,364,000 oz., compared with 55,361,000 oz. in 1920. Copper mines, the largest producers of silver, have been unable to take full advantage of dollar silver. Straight silver producers, in Nevada particularly, have been the most fortunate.

As a result of the flow of American silver into the United States Treasury, exports of silver from the country for the first eleven months of 1921 were only 44,430,350 oz., as compared with 107,535,300 oz. and 208,426,260 oz. for similar periods in 1920 and 1919 respectively. Imports also dropped, reflecting the smaller production of Mexico and Canada, being 57,726,767 oz. for the first eleven months of 1921, compared with 83,434,400 oz. in a similar period in 1920.

The world silver market was erratic throughout 1921.

Early in January foreign silver sold for 65⅜c. per oz., and after many fluctuations dropped to the lowest point of the year on March 5, when a quotation of 52⅝c. was recorded. Then began a steady climb to the highest price for the year, 73⅝c., reached on Oct. 17. For a time it looked as if silver would go even higher, but this hope was soon dispelled by a rather rapid decline. Although the average price of silver for 1921 is above the pre-war level, Mexican and Canadian producers found little encouragement in increasing production, owing to their high costs.

MONTHLY AVERAGE PRICE OF SILVER

| Month | New York 1920 | New York 1921 | London 1920 | London 1921 | Sterling Exchange 1920 | Sterling Exchange 1921 |
|---|---|---|---|---|---|---|
| January | 132.827 | 65.950 | 79.846 | 39.985 | 367.082 | 372.650 |
| February | 131.295 | 59.233 | 85.005 | 34.745 | 337.466 | 385.932 |
| March | 125.551 | 56.023 | 74.194 | 32.479 | 370.870 | 389.806 |
| April | 119.779 | 59.337 | 68.848 | 34.250 | 392.438 | 391.784 |
| May | 102.585 | 59.810 | 60.010 | 34.165 | 383.360 | 396.580 |
| June | 90.957 | 58.510 | 51.096 | 34.971 | 393.663 | 377.236 |
| July | 91.971 | 60.260 | 53.736 | 37.481 | 385.538 | 362.565 |
| August | 96.168 | 61.597 | 59.875 | 38.096 | 360.404 | 364.505 |
| September | 93.675 | 66.160 | 59.476 | 40.082 | 350.370 | 371.725 |
| October | 83.480 | 70.970 | 54.197 | 41.442 | 346.460 | 386.315 |
| November | 77.734 | 68.234 | 50.952 | 38.750 | 342.333 | 396.315 |
| December | 64.774 | 65.760 | 41.845 | 35.645 | 348.101 | 414.880 |
| Year | 100.900 | 62.654 | 61.590 | 36.841 | 364.840 | 384.191 |

New York quotations cents per ounce troy, 999 fine. London, pence per ounce, sterling silver, 925 fine.

The unusually high price of silver in 1919 and 1920, which caused practically every nation to take steps to protect its silver coinage from the melting pot, reaped part of its harvest in 1921. Some countries, because of the great depreciation of their currencies, witnessed the almost total disappearance of silver coins from circulation. Germany actually shipped large amounts of silver bullion from melted coin to the United States to be use as collateral for a loan. Great Britain reduced the fineness of her silver coinage almost in half, from 925 to 500. Other European countries turned to the base metals, copper, nickel, aluminum, and various alloys to satisfy subsidiary-coinage demands. In general, the use of the cheaper metals is the result of the existence of large quantities of depreciated paper currency and the impossibility of maintaining a simultaneous circulation of the precious metals and depreciated paper. Curiously enough, of all nations, Russia was reported during the year to be turning toward the coinage of silver.

China and India continue to be the pillars of the silver market. They were raised to unusually prosperous heights during and for a short time after the war, but the world-wide depression has had its effect upon them as well as upon all other nations. Both countries, being large producers of raw materials, have naturally felt the depression keenly. China and India were both buyers and sellers of silver during 1921. India's purchases were heaviest for the first part of the year. As usual, Far Eastern speculation has played an important part in the silver market, and some of the vagaries in prices can be ascribed to it.

What effect the changed conditions in India and China brought about by the war will have on the future of silver it is idle to attempt to guess. China during the war is estimated to have hoarded from 100,000,000 to 200,000,000 oz. of silver that confidence in government and trade may release. As silver dropped in price, large amounts of gold that had been purchased by China when silver was high were sold and converted into the currency medium of the country, silver.

Much depends upon the trade balances of these Asiatic nations as to the future demand for silver. During 1921 the trade balance of India changed from adverse, which it had been since June, 1920, to favorable. Favorable trade balances for the Far East require shipments of silver and gold in settlement. A good monsoon in India points to a continuation of satisfactory conditions in India for the next few months at least.

The next two years will pass rapidly for the American silver producer. There is nothing on the horizon to indicate that silver will soon cross the dollar line and so prolong the duration of the Pittman Act. No doubt when the time comes, the foreign silver market will reflect months ahead the completion of the United States Government's purchases and the effect of the American supply's addition to the world market.

The destruction of European silver currencies and the reduction of the fineness of others has partly made up for the deficit left by the withdrawal of American silver from the world market. The 500 fine British silver coins are expected to release 40,000,000 oz. of silver to the world's supply, irrespective of the total abandonment of silver by other countries.

Domestic silver consumption is becoming of increasing importance. The moving-picture film industry consumes about one-twelfth the domestic production of silver. It is unfortunate, in view of the attitude of European countries toward silver, that there are not other industrial channels of consumption equally promising. It is an anomaly that while the financial policies of Europe have dispensed with silver, the so-called "backward" nations have not diminished their regard for it.

# Platinum

BY JAMES M. HILL*
Geologist, U. S. Geological Survey

STOCKS of platinum at the beginning of 1921 were 46,747 oz., nearly 75 per cent greater than in the previous year. Imports for the first nine months of 1921 were 52,200 oz., or slightly lower than in 1920. However, the available platinum was apparently more than sufficient for the decreased demands, particularly of the jewelry industry, as the price for the metal continued to decrease until July, when the low level of $65 per oz. was reached. After midsummer there was an increase in price, and by mid-November $85 was asked for small quantities of platinum. More recently the market has eased, and it appears probable that platinum may decline further.

AVERAGE MONTHLY PRICES OF PLATINUM
Dollars per Troy Ounce in New York Market

| Months | 1917 | 1918 | 1919 | 1920 | 1921 |
|---|---|---|---|---|---|
| January | 87.83 | 105.92 | 104.85 | 154.23 | 73.400 |
| February | 103.75 | 107.68 | 100.43 | 151.59 | 70.227 |
| March | 103.33 | 108 (*nom.*) | 99.20 | 138.56 | 72.463 |
| April | 103.77 | 108 (*nom.*) | 99.85 | 127.04 | 73.404 |
| May | 105.00 | 106.27 | 102.60 | 97.50 | 73.740 |
| June | 104.75 | 105.00(a) | 105.80 | 85.19 | 74.942 |
| July | 103.88 | 105.00(a) | 105.90 | 83.94 | 70.440 |
| August | 104.55 | 105.00(a) | 107.60 | 111.44 | 73.222 |
| September | 104.13 | 105.00(a) | 128.70 | 115.20 | 75.960 |
| October | 104.00 | 105.00(a) | 132.21 | 101.70 | 81.800 |
| November | 104.52 | 105.00(a) | 136.74 | 84.75 | 82.609 |
| December | 104.38 | 105.54 | 151.35 | 79.62 | 78.192 |
| Year | 102.82 | 105.95 | 114.61 | 110.90 | 75.033 |

(a) Fixed price

Colombia still continues to supply over half of the crude platinum demand of the United States, though both England and France have contributed considerable metal. Japan has placed an embargo on the exportation of platinum, apparently with the purpose of building up a reserve, for she has taken over half of the

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unmanufactured platinum exported from the United States and has undoubtedly been in other markets as well.

Iridium, which was quoted at $325 per oz. at the first of 1921, gradually lessened in demand, apparently reflecting the slump in the automobile industry. By midyear, the price had declined to $160@$170 per oz. and it is reported that toward the close of the year holders of iridium or osmiridium could find no bidders for their metal.

It was hoped that Mr. Urquhart's negotiations in Russia might result in renewed mining activity in that country, but the Soviet government was not ready to listen to reason, so another year has been lost in reopening the world's richest platinum mines.

The Canadian nickel mines were closed in the fall of 1921, which will result in a loss of several hundred ounces of platinum and palladium a year. The Colombia production should continue to increase, and there is every reason to feel that the domestic market should have sufficient supplies during 1922 to assume a somewhat lower price for all of the platinum group metals.

# Quicksilver Mining

BY H. W. GOULD
Mining engineer and former manager, New Idria Quicksilver Mining Co., San Francisco, Cal.

DOMESTIC quicksilver mining, and, consequently, quicksilver production, reached the low ebb of its history in 1921. The output from domestic mines in 1921 was less than one-half that of any other year since 1850, and about one-sixth of the average annual production for the last seventy years.

At present, the industry is practically dead, with most of the mines completely closed down, their organizations scattered, and, in most instances, without sufficient capital to resume normal operations. The primary cause of this condition is the large importations of European metal in the last six months of 1920, and about 10,000 flasks during the first nine months of 1921. These importations, together with considerable stocks held by domestic producers on a market already affected by curtailed consumption in the United States on account of the general business depression, has forced the market as low as or lower than pre-war prices.

AVERAGE MONTHLY PRICES OF QUICKSILVER
Per Flask of 75 Lb.

| Month | New York | | | |
|---|---|---|---|---|
| | 1918 | 1919 | 1920 | 1921 |
| January | $126.77 | $105.50 | $90.192 | 48.440 |
| February | 119.89 | 89.84 | 84.432 | 49.545 |
| March | 121.63 | 71.56 | 92.611 | 46.796 |
| April | 121.87 | 72.94 | 102.192 | 45.423 |
| May | 118.97 | 83.12 | 89.560 | 47.000 |
| June | 122.66 | 93.25 | 90.154 | 46.846 |
| July | 126.63 | 104.68 | 90.333 | 44.950 |
| August | 125.56 | 107.08 | 83.806 | 45.028 |
| September | 127.81 | 102.52 | 75.000 | 42.660 |
| October | 127.18 | 86.35 | 67.200 | 39.840 |
| November | 124.91 | 90.74 | 58.417 | 39.804 |
| December | 117.70 | 98.27 | 49.577 | 49.212 |
| Year | $123.47 | $92.15 | $81.123 | 45.462 |

During the last year, I visited the quicksilver mines of Spain and Italy, including the Idria mine, now in Italy but formerly in Austria, and had a splendid opportunity to study the European outlook. Many important changes were effected in the industry in Europe during the war. Prior to 1914, German interests completely dominated the world's quicksilver market. The old Idria mine, producing about one-fourth of the world's quicksilver, was owned by Austria. The Monte Amiata group, in Tuscany, Italy, owned and operated by a German company, yielded about one-fourth of the world's production before the Great War. The great Almaden mine, in Spain, yielded nearly one-third of the world's quicksilver production, its product being sold through the English house of Rothschild. The German interests thus controlled 75 per cent of the world's quicksilver. American production, coming mostly from small, scattered mines, yielded less than 18 per cent of the world's total in 1914. Without adequate tariff protection the domestic industry was slowly dying.

At present, Germany is entirely out of the world's quicksilver market. Italy annexed the Austrian territory that included the Idria mine, and now owns and operates it as a government institution. An Italian company acquired the German interests at Monte Amiata during the war, and today this district is the largest producer in the world, and, with the Idria, gives Italy over one-half, and, possibly, two-thirds, of the world's production of mercury. Though Spain's production dropped from nearly 37,000 flasks in 1914 to less than 25,000 flasks in 1920, the Almaden mine is still yielding about one-third of the world's total. This metal is still sold by the Rothschilds in London, but the German influence has been removed.

WORLD'S QUICKSILVER PRODUCTION
In Flasks of 75 Pounds

| | Spain | Italy | | United States | Miscellaneous | Total |
|---|---|---|---|---|---|---|
| | | Idria | Monte Amiata | | | |
| 1909 | 40,933 | 19,294 (a) | 22,668 | 21,075 | 4,500 | 108,470 |
| 1913 | 36,619 | 26,710 (a) | 31,541 | 20,213 | 4,000 | 119,083 |
| 1917 | 25,133 | 25,000 (a) | 29,300 | 36,159 | 4,000 | 119,592 |
| 1921 (b) | 23,000 | 10,000 | 30,000 | 6,000 | 2,000 | 71,000 |

U. S. output dropped to 16,548 flasks in 1914.
(a) Austrian production. (b) Estimated by the writer.

The average cost in Europe of producing quicksilver is about $30 per flask. Adding $3 (10 per cent ad valorum duty) and $2 for freight and other charges, to this cost, makes a total of $35 per flask f.o.b. New York. If the European producer can sell at $40 per flask, he makes a fair profit.

If the effort were necessary, even with their present antiquated methods, the Almaden mine, in Spain, could produce quicksilver for less, on account of the very high-grade ore (7 or 8 per cent). The ore of the Italian mines averages from ¾ up to 3 per cent and they have splendid reduction plants, good engineering practice, and—most important—plenty of cheap and efficient labor. Against these conditions, the American mines are seriously handicapped by their very low-grade ore (¼ to ½ per cent) and high labor costs. Under the circumstances, it is doubtful if any American production of importance can be made under $50 per flask, and probably not much at less than $60.

The world's production of quicksilver today is about two-thirds of normal, based upon the pre-war figures. Consumption at the moment is even lower, owing to the general business depression and the absence of demand from Germany, once a large consumer. Any general increased demand can be supplied by the Italian mines.

As for the American quicksilver mines, the best they can hope for is to supply the domestic demand, and to do this an adequate tariff protection is necessary to keep them alive. The new Tariff Bill, already passed by the House, places a duty of 35c. per lb. on mercury, and, if passed by the Senate and signed by the President, it will afford the necessary relief and encourage many American mines to resume operations.

# Iron-Ore Mining in the United States

By D. E. A. Charlton
Managing Editor, *Engineering and Mining Journal*

THE SITUATION in iron-ore mining during 1921 necessarily reflects the general conditions that have existed in the iron and steel industry. The latter averaged 38 per cent operation, the decrease being due to steadily declining prices, despite high costs, which can be attributed largely to high freights and restricted operations.

The iron ore mined in the United States in 1921, exclusive of that which contained more than 5.5 per cent of manganese, according to the U. S. Geological Survey, is estimated at 29,547,000 tons, as compared with 67,604,465 tons in 1920. Shipments of ore from the mines in 1921 are estimated at 27,009,000 tons, valued at $89,688,000, a decrease in quantity of 61 per cent and in value of nearly 69 per cent as compared with the shipments in 1920. The average value of the ore per ton at the mines for the whole United States in 1921 is estimated at $3.32; in 1920 it was $4.11. The stocks of iron ore at the mines, mainly in Michigan and Minnesota, apparently increased from 11,378,794 tons in 1920 to 13,872,000 tons in 1921, or 22 per cent. The output of iron ore in 1921 was the lowest since 1904, when 27,644,330 tons was mined.

### Lake Superior Production Decreases 56 Per Cent

About 86 per cent of the iron ore mined and shipped in 1921 came from the Lake Superior district, in which 25,394,000 tons was mined and 23,155,000 tons was shipped, decreases of about 56 and 61 per cent, respectively, as compared with the quantities mined and shipped in 1920. The ore shipped in 1921 was valued at $81,091,000, a decrease of about 68 per cent. These totals include the ore mined and shipped from the Mayville and the Baraboo mines, in Wisconsin, and ore shipped by rail as well as water from all mines, but exclude manganiferous ores that contained more than 5.5 per cent manganese. The ore is chiefly hematite. The stocks of iron ore in the Lake Superior district apparently increased from about 10,366,738 tons in 1920 to about 12,575,000 tons in 1921, or 21 per cent. The shipments of iron ore by water in 1921 (including manganiferous iron ore), according to figures compiled by the Lake Superior Iron Ore Association, amounted to 22,300,726 tons, a decrease of 62 per cent as compared with these shipments in 1920. The average value of the ore at the mines in the Lake Superior district in 1921 per ton was $3.50; in 1920 it was $4.25.

The Southeastern states, which constitute the second largest iron-ore producing area, including the Birmingham and Chattanooga districts, mined 3,022,000 gross tons of iron ore in 1921, a decrease of 55 per cent as compared with 1920. The shipments of ore from these states to blast furnaces in 1921 amounted to 2,946,000 tons, valued at $6,343,000, a decrease in quantity of 56 per cent and in value of 67 per cent as compared with the quantity and value of shipments in the previous year. The ore contains about 78 per cent of hematite, 21 per cent of brown ore, and 1 per cent of magnetite. The average value of the ore in these states in 1921 per ton was $2.15; in 1920 it was $2.88.

The Northeastern states, which include New Jersey, New York, and Pennsylvania, in 1921 mined 668,000 tons of iron ore, and shipped 444,000 tons, a decrease of 68 per cent from the quantity mined and 79 per cent from the quantity shipped in 1920. The average value of the ore in these states in 1921 per ton was $2.88; in 1920 it was $4.90. Most of this ore is magnetite.

Arizona, California, Colorado, Idaho, Montana, Nevada, New Mexico, Utah, Washington, and Wyoming, the iron-ore producing states in the West, are estimated to have mined and shipped 429,000 tons of iron ore in 1921, a decrease of 42 per cent as compared with the quantity mined and shipped in 1920. The average value of the ore in this group in 1921 per ton was $1.96; in 1920 it was $1.97. Hematite predominates in the Western states, but considerable brown ore and magnetite are mined.

Other states, including Connecticut, Maryland, Massachusetts, and Missouri, in which there are small iron mines that produce chiefly hematite and brown ore, mined about 34,000 tons in 1921, a decrease of 49 per cent as compared with the quantity mined in 1920. The shipments from mines in these states in 1921 are estimated at 35,000 tons, a decrease of 46 per cent from shipments in 1920. The estimated average value of the ore from these states in 1921 per ton was $3.91; in 1920 it was $5.09.

### Conditions in Ore Business at End of Season

Regarding the outlook for 1922 in iron mining, the following relates to the Lake Superior districts, and the conditions therein outlined will apply to a greater or less degree to the other iron-producing districts. At the close of navigation in 1921 stocks of ore on lower Lake docks and at the furnaces were slightly under corresponding stocks the year previous. This might appear to be something of an anomaly, but it must be remembered that Lake shipments during the season were extremely light and that late in the fall the railroads announced a reduction in freight rates from lower Lake ports to interior furnaces, apparently with the idea of stimulating business for themselves as well as to give the furnace people the opportunity to take in, before heavy freezing weather should start, whatever ore they thought they might require to carry them over the winter. The result of this was an accelerated movement of iron ore from the lower Lake docks to the furnaces during the last six weeks of the season.

By the middle of December it had become apparent on the ranges, at least at some points, that the long drawn-out period of inactivity at the mines was beginning to tell upon the individual resources of the miners and that help during the winter in definite form would be necessary, to prevent positive suffering. Of course, such contingenies had been foreseen by the individual companies, and plans made to meet the situation. It was doubtless, however, with this situation in mind, that beginning in December, some of the large operating companies issued instructions to reopen certain properties on the different ranges, with the result that probably from fifteen to twenty mines on the Mesabi, Cuyuna, Gogebic, Menominee and Marquette ranges have been placed in production again on some scale—either reduced wages, reduced time, or both.

Last season (1921) between 22,000,000 and 23,000,000 tons of iron ore was brought down the Lakes—the smallest movement in twenty years or more. This compares with around 57,000,000 tons for 1920, which, notwithstanding the large production in one or two of the war years, is probably close to the normal season's requirements today, and, if anything, a little under such normal requirements. Based on the above figures and an estimated operation at furnaces and the steel mills during the next eighteen months, there is a general agreement in the estimate as to the movement of iron ore for the season of 1922. It is expected now that during this next season between 40,000,000 and 45,000,000 tons of ore will be moved down the Lakes. This is, of course, 100 per cent greater than 1921 and cannot be looked upon as anything but a great improvement over that year. By the same token, it will also be seen that this is still considerably below what now appears to be a normal season's movement. Neither is this estimate based on any abnormally favorable operation of furnaces or steel mills. On the contrary, it is assumed that the improvement in operation at these plants will be gradual but steadily better, with the result that perhaps at the end of eighteen months operations will be 80 to 85 per cent of normal.

The movement of 40,000,000 to 45,000,000 tons of ore will create a much broader mining activity on the Lake Superior ranges. Just what it does denote in individual operations cannot be foretold, as this is bound to depend to some extent upon the demand for the various grades of ore that may be produced, and this, in turn, is contingent upon trade requirements and the needs of the furnaces and mills. But it should be remembered that it was only a few years ago that 45,000,000 tons was considered a normal year, and if one looks back and considers what such a year at that time meant in activity upon the ranges, a better comprehension can perhaps be obtained as to what it would still signify, especially as compared to the season just past.

### Is Minnesota "Profits" Tax Constitutional?

During the early part of 1921, action was taken by the Minnesota Legislature on a "profits" tax of 6 per cent on the assumed net profits from mining iron ores, the revenue thereby obtained accruing to the state general funds and not to the municipalities affected. So far, no one seems to know what the result of that tax is to be. Estimates have been made from $1,000,000 a year to $4,000,000 or more, but probably under normal conditions and with an output of 45,000,000 tons the tax will amount to about $2,000,000. That is in addition to the ad valorem taxes now levied for state and local purposes, and which are distributed as other taxes—i.e., to the municipalities, the counties in which the mines are situated, and the state on the regular apportionment basis. The Legislature, in passing the act legalizing this profit tax, specified certain items of cost which it stated were to be the cost of producing ore and which were to be deducted from the price obtained for ore, so as to determine the net value; but it did not include all of these items, and it is probable that the law, if and as enforced, will fail to take cognizance of all cost items, instead of part of them. It is not certain that the law is constitutional, and everyone expects that when it comes to the question of payments under it the mining companies will decline to pay until the courts have interpreted the act and its legality is acknowledged.

# Manganese Mining

By H. A. C. Jenison*
Geologist, U. S. Geological Survey

THE domestic production of high-grade manganese ore in 1921 amounted to about 13,000 tons, more than 10,000 tons of which came from Montana. The production of ore of intermediate grade, containing 10 to 36 per cent of manganese, was about 72,000 tons. The production of low-grade manganiferous ore was about 14,000 tons.

Net imports for the first eleven months of the year amounted to about 386,405 tons of high-grade ore and oxide, valued at $3,288,595. Of this, Brazil contributed 247,568 tons, valued at $7.58 per ton, and India 113,730 tons, valued at $6.46 per ton.

The general business depression of 1921 is only partly responsible for the extremely small domestic production. It is unlikely that a greater steel production would have resulted in a larger consumption of domestic ore, as adequate supplies of higher-grade and cheaper foreign ore were available. The fundamental causes for the decrease in domestic shipments are undoubtedly the higher cost of production, the lower grade of ore in comparison with foreign ore, and the uncertainty of a sufficient supply. A small part of the domestic ore, particularly that of the Philipsburg district, is well suited to chemical uses, and as such enjoys a special market unavailable to most of the domestic ore.

In considering the future of the domestic industry the country's reserves must be divided in three classes: (1) high-grade chemical ore; (2) high-grade ore and ore capable of beneficiation; (3) low-grade ferruginous or manganiferous ores. The future of ore of the first class is fairly bright, as it is of such character and grade, and is produced at so moderate a cost, that it may be sold in profitable competition with foreign ore, except perhaps with Russian ore, and should find a market for an indefinite period. Most of the ore of the second class cannot be mined at a profit under normal conditions in open competition with imported ore. The acquisition of high-grade foreign deposits by American capital, particularly by steel producers, promises production of such ore at reduced cost and the certainty of adequate supplies of desired grade.

According to recent and reliable information, the Soviet government of Russia has recognized unconditionally the Tempo Company's right to the Tchiatouri deposits, which will be worked by the Dutch firm of Vlessing & Co. under an agreement which will give that company a monopoly of the sales of ore from the deposit. This agreement appears to assure a supply of Russian ore of satisfactory grade at American ports at pre-war or lower prices. The pre-war cost of this ore, mined by primitive methods, was about $5.70 per ton aboard ship at the port of Poti.

It has been officially reported that a French syndicate has acquired the Marquesa deposits of Chile, and is installing sufficient equipment to produce 300,000 tons of ore per annum from this source. This ore averages about 50 per cent manganese, 8.5 per cent silica, and 1.5 per cent iron, has a maximum of 0.02 per cent phosphorus, and now costs $3.50 to $4 per ton at Chilean seaport.

The acquisition and development of Brazilian deposits

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by American and Anglo-American capital, the development of Chilean deposits, the renewal of Russian production upon a modern basis, and the renewal of imports from India promise keen competition among foreign producers for the American market, and a selling price of high-grade foreign ore that will be unfavorable to domestic production.

To meet foreign competition, a tariff of 1c. per lb. of metallic manganese content in excess of 30 per cent metallic manganese content of ores and concentrates imported has been reported favorably by the House, but is still pending in the Senate. The proposed tariff would impose an import duty of about $4 per ton on Russian, Indian, and Chilean ore, and $3 to $4 per ton on Brazilian ore.

## Chromite Mining

BY SAMUEL H. DOLBEAR
Consulting Mining Engineer, New York

CHROMITE consumption in all parts of the world in 1921 was about 60 per cent of that of 1920. Mines in the United States were for the most part closed down entirely during the year, and the limited tonnage shipped came largely from stocks remaining in producers' hands from as far back as the close of 1918. On Jan. 1, 1919, the U. S. Geological Survey estimated chromite stocks at 42,687 long tons. Shipments from these stocks in 1919 were 5,079 tons, and in 1920, 2,502 tons. The shipments are reported to include some new production, so that the visible supply of domestic ore mined but not shipped still remains at about 35,000 tons, or more than 80 per cent of the 1919 carry-over. Much of this is situated at points so remote from rail that it is not expected to find its way into domestic markets.

California operators mining to a moderate extent in 1919 and 1920 were closed down in 1921, and some of the larger operations were definitely abandoned, as was the situation with the Placer Chrome Co., controlling mines and a concentrating plant near Newcastle. No ore was produced in Wyoming, and but little activity was reported in eastern Oregon.

The industry in the Province of Quebec, Canada, was similarly depressed, and the outlook for 1922 is not considered bright. According to figures of the U. S. Geological Survey, 7,553 long tons was imported from Canada during the first eleven months of 1921.

Under pre-war conditions, New Caledonia and Rhodesia supplied most of the ore for American consumption. The Caledonian mines are so situated as to furnish convenient ballast cargo for Australian shipments of other merchandise, thus commanding a low freight rate. They are also close to water transportation. Rhodesian mines, though less fortunately situated, continue to increase in importance. Some of the mines are large and well equipped, and the chromite-bearing areas are extensive. Production is second to that of Caledonia, and in time will doubtless exceed it under normal conditions.

There are eighteen known chromite deposits in Turkey in Asia, which have been operated, the more important shipments of late coming from the Karli Yer mine. The output in 1920 was said to have been 25,000 tons, but it is believed that not more than a third of this amount was shipped during 1921. Development of the Cuban deposits was begun in 1918 by American steel interests, and in 1919 Cuba shipped more ore to the United States than any other country. In 1920, shipments of ore fell to about 700 tons, no shipments being reported for 1921.

Total imports for the first eleven months of 1921 were 81,835 tons, and for the year will likely show not more than 85,000 tons. A wide difference in the declared value of the ore from different countries is to be noted. From Greece and Turkey the value is over $20 per ton, as compared to $3.40 from Rhodesia and $5.65 from New Caledonia. The average declared value is about $8 per long ton. Imports decreased 65,000 tons, as compared to 1920.

## Nickel Mining

BY THOS. W. GIBSON
Deputy Minister, Department of Mines, Ontario, Canada

THE slow industrial recovery has heavily affected nickel mining. Stocks of the metal accumulated during the war years have not yet been absorbed. Disarmament and scrapping of navies we all rejoice to see, but they mean that one of the most important markets for nickel goes with the navies to the scrap heap. The conditions have brought nickel mining almost to a standstill. The end of 1921 saw all the Sudbury smelters cold, except for one furnace, the mines nearly all idle, and the refineries shut down.

Resumption of activity will come with a revival of manufacturing, especially of steel. The abolition of war will not mean the disuse of nickel. The toughness, tensile strength, and resistance to corrosion which 2.5 to 3 per cent of nickel imparts to steel will insure its use wherever these qualities are essential; for automobile steel, for axles, tires, piston rods, bridge building, railway frogs and switches, resistance wire, nickel-silver, coinage, plating, as a catalyzer for fat hardening, in cooking and kitchen utensils, electrical instruments, acid-resisting equipment, and numerous other uses nickel will be required.

The mines of the Sudbury district, in the Province of Ontario, Canada, produce about 85 per cent of the world's requirements of nickel. The known ore reserves in the Sudbury mines amount to 150,000,000 tons or more. For refining purposes the low-grade matte is sent to Port Colborne, Ont.; Deschenes, Que.; Bayonne, N. J., and Clydach, Wales. The three companies operating the mines are the International Nickel Company of Canada, Ltd., the Mond Nickel Company, Ltd., and the British America Nickel Corporation,, Ltd.

The silver ores of the Cobalt district in Ontario contain nickel and also cobalt, which are recovered in the silver refineries, and nickel oxide, nickel sulphate, and metallic nickel are produced.

The production of nickel in 1921 from the Ontario deposits was approximately 5,200 tons, and of copper 4,800 tons. This contrasts with about 28,000 tons of nickel and 15,000 tons of copper in 1920. The peak production during the war was in 1918, when 45,886 tons of nickel and 23,843 tons of copper were recovered. Besides nickel and copper, the Sudbury ores contain appreciable quantities of gold and silver, and are important sources of platinum and palladium. In 1920, the recoveries of platinum amounted to 8,400 oz., and of palladium 10,200 oz. Gold was obtained to the extent of 1,260 oz., and silver to the amount of 120,000 oz. Other metals of the platinum group, such at ruthenium, rhodium, and iridium, are also obtained in small quantities in refining. This production was not from the ore mined in 1920, but principally from residues or products resulting from previous refining processes.

# Tungsten Mining

BY FRANK L. HESS*
Geologist, U. S. Geological Survey, Washington, D. C.

TUNGSTEN MINING in the United States in 1921 was reduced practically to zero. So far as is known, no ore was mined anywhere in this country except a few tons taken out by the Wolf Tongue Mining Co. in the course of a little development work carried on at its Cold Spring mine, near Nederland, in the Boulder (Colorado) district. Not a wheel was turned in the mills.

The world's tungsten market has been wholly overshadowed by the Chinese production. The placer deposits of Kwangtung and Kiangsi have proved so large and so cheaply worked that there has been no possible competition even from Tavoy, and in the face of a quiescent high-speed steel business, Chinese ore has continued to reach both European and American ports, and weak British holders have sold good ore for 11s., or an equivalent of less than $1.85 per short ton unit, the lowest prices ever known.

The possibility of a tariff has kept ores, ferrotungsten, and metal coming into the United States, and a great stock has been built up. During the first ten months of the year, 1,341 short tons of ore was imported, of which 978 tons came from China.

An equivalent of more than 13,000 short tons of concentrates carrying 60 per cent $WO_3$ is probably on hand, and considering the normal consumption to be 3,000 tons, it is readily seen that even the highest of tariffs cannot justify tungsten mining again for several years.

Tungsten mining in the United States, to get into full blast, must wait on the steel business; on the depletion of stocks both in the United States and abroad; and in less degree on the depletion of the Chinese placer deposits. For whether or not Chinese deposits supply the United States, they will supply its rivals in the steel trade, and the competition must be met either here or abroad.

# Molybdenum

BY B. F. PHILLIPSON
President Climax Molybdenum Co., New York

THE PROGRESS in the industrial application of molybdenum during 1921 cannot be measured by the production in this country during that period, because of the general economic situation. No molybdenum ore was mined during the last year. However, greater progress was made in the commercial development of the metal in 1921 than during the entire preceding four years. The reasons for this statement will be apparent if the following technical papers on the subject are read: "A Suggested Method for Determining the Comparative Efficiency of Certain Combinations of Alloys in Steel," by J. D. Cutter; "A Discussion of Molybdenum Steels," by Charles McKnight, Jr.; and "Molybdenum Steel and Its Application," by M. H. Schmid. These three papers appear in the *Transactions* of the American Society for Steel Treating of December, 1920; March, 1921, and June, 1921, respectively. Further interesting information and pertinent data will be found in "Molybdenum Steels," by John A. Mathews, in *Transactions* of the American Institute of Mining and Metallurgical Engineers, February, 1921, "Molybdenum," by Arthur H. Hunter, American Iron and Steel Institute, May, 1921, and "Application of Chrome Molybdenum Steel From the Consumers' Standpoint," by C. N. Dawe, to be presented before the Society of Automotive Engineers in January, 1922.

From a purely technical standpoint, the fact that steels containing molybdenum in fractional percentages ranging from 0.15 to 0.75, but never exceeding 1 per cent, have been extensively adopted as standard by some of the foremost manufacturers of automobile and automobile parts, as well as in the manufacture of such other products as die blocks, drop forge piston rods, shovels, pneumatic tools, railway parts, mill rolls, seamless tubing, and similar products indicates the quality of the molybdenum structural steels.

The molybdenum steels can be produced at a cost entirely competitive with other alloy steels of comparable physical properties. There is also the additional fact that molybdenum is the only one of our commercial alloying elements available in sufficient quantities within our borders to take care of all the requirements of the domestic industry.

Molybdenum is no more a panacea for all the ills of steel than any of the other established alloying elements, but, imparting as it does to steel at a commercial cost certain marked advantages not obtainable otherwise, and being available in extraordinary tonnage quantities in this country, its future in the steel industry is assured.

# Vanadium Mining

BY R. B. MOORE*
Chief Chemist, U. S. Bureau of Mines

OWING to the slump in the automobile industry early in 1921, the production of vanadium was seriously curtailed. The Vanadium Corporation of America produces the larger part of the vanadium used in this country at its mines at Minasragra, Peru. The last shipment of concentrates from Peru to the United States was in the early part of the year, and no shipments have been made since that time, although considerable stocks of vanadium ore had accumulated in this country, and are now available.

Business for a short time was better during the summer of 1921 than it had been in the spring, especially during July and August, but in the fall there was another drop in the demand, and this was maintained until the first of 1922.

No ore was mined primarily for its vanadium content during 1921 in the United States. A fair amount of vanadium was, however, produced as usual as a byproduct in the extraction of radium from carnotite ore. Up to the middle of 1920, there was a tendency on the part of a number of operators to be interested in high-vanadium, low-uranium ores in the Paradox and surrounding districts, making vanadium the main product and radium the byproduct. An ore carrying 6 or 7 per cent $V_2O_5$ and from 0.5 to 1 per cent $U_3O_8$ was in strong demand. This condition has now entirely changed, and all vanadium from carnotite has been a byproduct, with radium the main objective.

Two plants near Newmire, Col., treating roscoelite ore, were shut down during the whole year, and there has been no production from these plants. The Vanadium Corporation has continued a moderate amount of

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development work at its properties in Peru. The branch railroad from the lake to the main line has not yet been completed, although the loose rails are down. Work has been temporarily discontinued on this improvement.

Owing to the fact that a large percentage of the ferro-vanadium produced during 1921 was made from accumulated stocks of vanadium ore, it is not possible to give the actual production for the year.

Prices during the spring ranged from $5 to $5.75 per lb. of contained vanadium in the ferro, f.o.b. works. The variation in price depended upon the amount of impurities present, such as silica and like materials. There was a slight reduction during the summer, the price dropping to from $4.50 to $5 per lb. A number of lots of resale material have been sold recently at a price slightly under that quoted.

# Uranium and Radium Mining

BY RICHARD B. MOORE*
Chief Chemist, U. S. Bureau of Mines

THE general business depression probably influenced the radium business a little later than that of the other metals. Whereas the industry had slowed up to some extent during the latter part of 1920, production continued on a fair basis during the spring of 1921, and during the summer. It was not until September that the mines of most of the operating companies were shut down, although ore production had decreased to some extent before this period. The plants operated in a fairly consistent manner during 1921, and in practically all of the companies fractionation work continued up to January, 1922. Even after a plant has closed down, it usually takes from two to four months to clean up all of the accumulated radium concentrates. In addition, most of the operating companies always keep a fair store of ore ahead, so that it is not necessary for the extraction plants to close for some time after mining operations have ceased.

Operations have continued with few exceptions in the old districts. The Standard Chemical Co. has been getting a large part of this ore as usual from the Club Ranch and surrounding neighborhood. The company has, however, been producing a considerable amount of its ore from the south side of the Paradox Valley west of the Jodandy claim. This is a district that was temporarily abandoned several years ago, but new beds of ore have been opened up, and production has continued.

The operations of the other companies, the Colorado Radium Co., the U. S. Radium Corporation, and the W. L. Cummings Chemical Co., have necessarily been more limited, as they do not possess as many claims as the Standard Chemical Co. controls.

Little was done around Thompson's during 1921. Operations around Temple Mountain, Utah, were closed down in August. A fair amount of development work has been done in this district, where the ore is usually high in vanadium but rather low in uranium. A new district opened up during the year as an extension to the south of the proven fields is near the Carrizo Mountains, on the border of New Mexico and Colorado. Some fair ore showings have been found in this locality, and though the ore is not as high grade as further north, a fair production may be expected.

Prices of ore in 1921 remained about the same as during 1920. Most of the ore produced is mined by the operating companies themselves, and only a relatively small quantity is purchased in the open market or through agents. For several years it has been the custom to pay for the vanadium as well as for the uranium content. Recently, on account of the slump in the vanadium market, prices on the vanadium content of the ore have been reduced, but prices for the uranium in the ore have been approximately the same as for 1920. There is some small variation in the prices offered, but generally speaking, they are about as follows: 2 to 2½ per cent $U_3O_8$, $2.25 per lb. $U_3O_8$; 2½ to 3 per cent $U_3O_8$, $2.50 per lb. $U_3O_8$; 3 to 3½ per cent $U_3O_8$, $2.75 per lb. $U_3O_8$. Ore has been sold containing as low as 1 per cent $U_3O_8$. Ore of this grade, however, has usually been high in vanadium. More recently the tendency has been, owing to the lack of demand for vanadium, for the dealers to be less interested in the lower grades of ore.

A deposit of uranium minerals in Katanga, Africa, was announced during 1921. This is near the town of Elisabethville, and is on the property of Union Minère du Haut Katanga. Meager information has yet been given out concerning the possible production, but the owners appear to be optimistic over the possibilities of this deposit for the extraction of radium.

The production of radium in this country during 1920 was 32½ gm. The production during 1921 will undoubtedly be greater, and will exceed 35 gm. This is in face of a depressed market, and shows that the radium producers have been inclined to go ahead with confidence.

Prices of radium have remained steady, and are practically the same as in 1920. For small lots of radium, the price varies from $115 to $120 per mg. of radium element. For larger lots, purchases under competitive bid, the price is less and depends upon the amount of radium involved.

Mesothorium has become well established as a substitute for radium in certain uses, particularly for luminous paint. Both the Welsbach Company and the Lindsay Light Company has been steadily producing mesothorium as a byproduct in the manufacture of thorium nitrate for gas mantles. The mesothorium always contains from 12 to 25 per cent radium, and, in practice, the manufacturers of luminous paint usually add a little more radium so as to bring the percentage of radium up to a slightly higher figure than is natural in the mesothorium. As this product has the life of five or six years after it has "ripened" for about a year, its use tends to conserve radium for therapeutic application, research, and experimentation.

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# Arsenic Industry

BY V. C. HEIKES*
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PRODUCERS of arsenic in the United States marketed in 1921 approximately 5,732 short tons of crude and refined white arsenic, compared with 11,502 tons, valued at $2,021,356, in 1920. A considerable amount of arsenic is held at points of production and in consumers' hands, and only a small quantity of the supply was manufactured into fungicides.

Large stocks of calcium arsenate, said to aggregate 5,000 tons, were reported at the close of 1920, so the situation was not encouraging to producers. A part of the supply was sold in 1921, and the remaining por-

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tion, about 1,000 tons, which had begun to deteriorate, was in the hands of manufacturers and distributors. These warehouse stocks of insecticides were accumulated by an anticipated demand, so that when the South did not buy, producers had no outlet for their holdings.

The largest producer of arsenic in 1921 was the U. S. Smelting, Refining & Mining Co., whose output for the most part was made into fungicides at its Midvale plant. Very little of the white arsenic produced at Tacoma, Globe, and Anaconda was put on the market, and most of this was sold to manufacturers of fungicides and refiners making the higher-grade arsenic demanded by plate-glass works.

The price of white arsenic gradually fell from 11c. per lb. in February, 1921, to 6c. per lb. in November, with few offerings. Toward the last of November, there was an improvement in the insecticide business, and agricultural buying for spring trade was a feature of the market, with forward deliveries commanding a premium.

Prices for white arsenic near the close of 1921 were 7¼c. per lb. Red arsenic decreased from 15 to 11c. per lb. during the year, and quotations for calcium arsenate were steady, ranging from 16 to 20c. per lb.

An increased demand for the products made from arsenic suggests a better price for the raw material in the near future. It is not likely that the foreign arsenic will interfere with the domestic production, as most of it, except that produced in Mexico, will be consumed locally or shipped to foreign dealers.

The future of arsenic production depends mainly on its use in the cotton regions and on railroad rights of way, but there is a prospect that the alfalfa-growing regions will develop a considerable demand, and the use of arsenical insecticides on intensively grown crops is steadily increasing.

# The Petroleum Outlook

By John D. Northrop*
Land Classification Board, U. S. Geological Survey, Washington, D. C.

THE PREDOMINANT ELEMENT in the petroleum industry at the dawn of 1922 is uncertainty. Has the post-war depression run its course as far as the petroleum industry is concerned, or are still lower levels to be traversed before substantial improvement may be expected or complete recovery assured? The evidence at hand does not yield a categorical answer. Its elements conflict, and are in places, seemingly, if not actually, contradictory.

On the adverse side of the ledger, the pessimist finds occasion to view with unfeigned alarm the financial and economic paralysis of the world in general and of Europe in particular, with its attendant constriction of foreign demand for petroleum products and its demonstrated capacity for preventing able-bodied oil-burning merchant vessels from engaging in active service. He notes also the slow progress of domestic industry toward normal activity and joins lustily in the anvil-chorus of invective against the ruinous costs of railway transport. With regard to the products of the petroleum industry he finds, on the one hand, a keenly competitive market, listless as to demands and bearish as to prices, and on the other hand the usual seasonal decline in the consumption of gasoline superimposed on an accumulation of stocks of the principal refinery products, other than kerosene, that is without precedent in the history of petroleum refining. As to crude petroleum, he observes a ready market for all oil offered at prices that barely cover the cost of production, a persistent increase in stocks, a steady influx of cheaply produced Mexican oil, and a threat of overproduction and market relapse in the daily gain in proved productive capacity of the newly found oil fields near Mexia, Tex.; Haynesville, La.; Eldorado, Ark., and Burbank, Okla.

There are, however, other factors, and other aspects of the same factors, that disclose a state of affairs by no means hopeless. Because they reflect basic rather than transitory conditions their effect is decidedly cheering.

On the favorable side of the general ledger, the optimist points with pride to the staple character of the commodity with which he deals, to the diversity of its applications, and to the indispensable rôle it plays in industry, transportation, agriculture, and everyday life. He notes the spirit that pervades the international conference on armament limitation and the Anglo-Irish compromise, reads its tangible expression in a stiffening of foreign exchange, and interprets the progress made in terms of European rehabilitation that must inure to the ultimate benefit of the American petroleum industry. With regard to industrial conditions at home, he observes the persistence, rather than the deliberation, with which the pathway to normal activities is being sought, found, and relentlessly pursued, and counts each shaft, spindle, pulley, and wheel restored to motion as an embryonic market for his wares.

The optimist enters even the idle tankers and oil-burning merchant vessels in our harbors as assets, listing them as prospective customers, as available delivery vehicles and as guarantees that the domestic petroleum industry will not run short of raw material so long as it is available in near-by countries. In this connection he finds it impossible to overlook the fact that the quantity of bunker oil furnished at American ports to vessels engaged in foreign trade in the first nine months of 1921 aggregated 20,252,215 bbl., and is greater by 11 per cent, 130 per cent, and 323 per cent, respectively, than in the corresponding period in 1920, 1919, and 1918.

With respect to railway tariffs, the optimist derives a modicum of cheer from the facts that all the great industries are equally affected with his own, that substantial industrial prosperity cannot coexist with railway adversity, that the highway to railroad prosperity is largely financial, and that, since the petroleum industry, as the purveyor of about 40,000,000 bbl. of locomotive fuel annually, is in a position to benefit directly by railway prosperity, its contributions to railway betterments are not without interest-paying possibilities.

Turning, then, to the matter of refinery products, the optimist perceives that all is not as dismal as might at first appear. With respect to gasoline, he finds that the

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domestic and foreign market absorbed 3,817,638,979 gal. in the first nine months of 1921, and that this quantity is greater by 3.4 per cent, 30.4 per cent, and 30.6 per cent, respectively, than the quantity absorbed in the corresponding periods in 1920, 1919, and 1918. He notes that the indicated rate of consumption in 1921 averages around 424,000,000 gal. per month, and with this in mind calculates the stocks on hand at refineries the country over as equivalent to less than a six weeks' reserve. He finds therein no warrant for general dismay, although he concedes that this condition may lead to local unsettlement in localities where competition is particularly keen and storage space is already occupied.

A glance at the automobile industry suggests that some part of the failure of gasoline consumption to increase in 1921 at the average rate of 40 per cent attained in other recent years may be attributed to anticipation by the public of the deflation that is now in progress and a consequent postponement of motoring "joys" until a later date. In any event, the lowering of automobile prices is certain to stimulate buying and to result in a demand for gasoline next summer.

As to kerosene, the situation is well in hand as judged by statistics for the first nine months of 1921. These show decrease of production, consumption, and stocks as against the same period last year, despite a gain of about 5 per cent in the quantity of crude oil refined. Similar evidence concerning lubricating oils indicates a moderate decrease in production accompanied by proportionately greater decreases in domestic consumption and foreign shipments and by a doubling of refinery stocks compared with a year ago.

The mettle of the optimist is severely tested as he contemplates the situation of gas oil and fuel oil. He finds them a drug on the market, selling below their cost of production and accumulating in refinery storage at the rate of 1,000,000 bbl. a month. The surplus accumulated to the end of September aggregated about 29,300,000 bbl. and was 60 per cent larger than on the same date in 1920. In consideration, however, of an average monthly outgo of nearly 18,000,000 bbl., an accumulated excess of 30,000,000 bbl. more or less would not seem to afford the basis for much apprehension were it not for the close interrelation that exists between the market for fuel oil and the market for the lower-gravity types of crude petroleum. The former cannot substitute for the latter, but, within certain limits, the latter can substitute for the former; hence, the availability, supply, and price of crude largely control the situation as to fuel oil.

With respect to crude petroleum, the evidence at hand, comprising statistics for the first eleven months, indicates for 1921 a production of about 467,000,000 bbl. This constitutes a gain of about 6 per cent over 1920, but reveals a deficiency in production as compared with consumption that aggregates approximately 50,000,000 bbl. Importations from Mexico made good this deficiency and added about 54,000,000 bbl. net to the reserves of crude oil in the United States prior to November 30. At that time the total stocks of crude oil on hand amounted to 176,006,000 bbl., equivalent to a four months' supply at the current rate of consumption.

The collapse of the crude-oil market in the first half of 1921, which reduced "Pennsylvania grade" from $6.10 to $2.25 per bbl., and "Oklahoma-Kansas grade" from $3.50 to $1 per bbl., followed as a natural consequence of the overproduction developed in response to the high prices established in the spring of 1920 and consistently maintained throughout that year. The extremely low levels reached by prices in midsummer 1921 brought about so vigorous a curtailment of field activity as to threaten a serious shortage of crude within a few months. As a result, prices reacted sharply during the fall months to levels that at least cover the bare cost of production, even though they provide little or no incentive for wildcatting.

With field activity pared to the bone and three months of winter still to run, with production diminishing from the old wells, and with domestic requirements exceeding domestic production by an average of 4,000,000 bbl. per month, and ranging as high as 10,000,000 bbl. per month, the only apparent obstructions to immediate advances in the price of crude oil at the wells are Mexico and the new oil fields discovered in the southwestern states in 1921. Both are uncertainties as yet, and until their measure is taken the market for domestic crude may be expected to pursue its present conservative course.

The growing conviction that the days of Mexico's big and cheap production of refinable oil are numbered, and that the number is astonishingly small, tends to offset any misgivings that might otherwise arise as to the effect of the rather unexpected injection of about 200,000 bbl. per day of new production into the domestic crude-oil situation.

The keenness of the competition displayed by the purchasing agencies for the new production unearthed at Mexia, Haynesville, Eldorado, and Burbank, and the record-breaking bids offered at the December sale of leases on prospective oil land in the Osage Indian Reservation, Oklahoma, point unmistakably to a vital concern for assured supplies of crude oil that cannot long avoid reflection in market quotations, for the better grades of domestic crude at least.

The algebraic sum of the factors briefly set forth in the foregoing discussion permits for the domestic petroleum industry as a whole no other forecast of conditions in 1922 than generally fair with rising temperature, accompanied probably with clearing showers and other evidences of unsettlement, temporary in duration and purely local in extent.

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# Barytes Mining

BY J. B. PIERCE, JR.
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THE barytes mining industry underwent a severe decline toward the end of 1920 and throughout the entire year of 1921. Figures for actual production for 1921 are not available, but there is no doubt that a decided shrinkage will be shown in comparison with those for 1920 and 1919.

The tariff question appears to be the critical turning point of the domestic barytes industry. If adequate protection is not accorded, the industry cannot survive. German barytes, because of its vein formation, permitting of lower mining costs (no mechanical preparation being required), together with the lower ocean freights as compared with the cost of rail transportation from the domestic producing areas to the Eastern seaboard consumers, can be laid down in the United States at a cost which domestic producers can not possibly meet.

Barytes could be contracted for at the close of 1921 for $6.25 per short ton, at the mines. The freight rate

is from $5 to $8 per long ton on the domestic ore to northern seaboard territory, depending upon its point of origin. The tariff, as proposed in the present bill, of $4 per ton, will scarcely enable domestic producers to compete with the imported ore in seaboard territory, but should give them the entire internal business of the country.

## Bauxite and Aluminum

BY JAMES M. HILL*
Geologist, U. S. Geological Survey

THE domestic consumers of bauxite were apparently well supplied during 1921 with both domestic and foreign material. The market quotations for crude have been constant at $8 to $10 per ton. Dried pulverized bauxite commands a premium of $4 to $5 per ton, and calcined is quoted at $20 at shipping point.

The total imports of bauxite for the first nine months of 1921 were 21,571 tons, having a declared value of $7.62 per ton. The imports from British Guiana for the first five months of the year were 10,545 tons, or nearly half of the total imports for the nine-months' period.

The Demerara Bauxite Co. closed its plant in British Guiana early in 1921, presumably owing to the slackened demand for bauxite in the United States and to the fact that the colonial office had made no regulations under which it could operate. It is reported, however, that the "British Bauxite Co.," formed no doubt at the instigation of the British government during 1921, is to develop all the bauxite lands on the Demerara River, not already controlled, upon condition that their output go to British aluminum interests.

In Dutch Guiana, the bauxite deposits at Moengo, 160 km. from the mouth of the Commewyne River, are under development. The Dalmatian and Istrian bauxite mines are on a producing basis, and it is reported that high-grade material from these deposits is now being delivered in the United States.

Large bauxite deposits in the Bakony district, Hungary, have recently been discovered, and a company has been organized to operate them.

France has placed a 20 per cent ad valorem duty on the export of bauxite, as a consequence of which it is said that some of the mines have been closed.

The demand for aluminum in the United States has apparently been less than for some time, reflecting in part the depressed condition of the automobile industry. Quotations for domestic aluminum, which at the first of 1921 were 28.3 to 28.5c. per lb., declined to 24.5 to 25c. in July and in November were cut to 20c. Foreign aluminum was quoted from 3 to 7c. cheaper. Imports of crude aluminum for the first nine months of 1921 were 26,177,852 lb. with a declared value of 22c. per lb., and exports of domestic aluminum in the same period totaled 1,024,346 lb., valued at 27c. per lb.

French aluminum plants are reported to be operating at about normal capacity, but the German plants are having difficulty, as many of them derive their power from coal, and are therefore at a disadvantage.

Japan is still endeavoring to establish an aluminum industry, latest reports being of a semi-governmental investigation of a new (?) process for extracting aluminum from local raw materials.

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The Aluminum Company of America has indicated that a raise of 5c. per lb. on the import duty of pig aluminum would be acceptable. Consumers, however, are of the opinion that the present duty of 2c. per lb. on ingot and 3½c. per lb. on sheet aluminum is sufficient protection for the firmly established domestic industry.

The outlook for both producer and consumer of aluminum in the United States is encouraging. The United States has a well-developed, strongly organized company, whose policy of enlargement to meet the increased demand is well known. Also, there exists the possibility that in the near future other interests will be producing aluminum.

Consumers are in good position, for the prices have receded and will probably continue downward, for, with French and Norwegian aluminum now coming in considerable quantities, it is hardly probable that prices for domestic aluminum can be held at unreasonable figures.

## The Borax Industry

EDITORIAL STUDY

THE notable event of 1921 in the borax industry was the discovery of another important colemanite deposit. The finding of the mineral in Clark County, Nev., was described in *Engineering and Mining Journal* of Oct. 1, 1921, on p. 524. F. M. Smith secured control of the new deposit for the West End Chemical Co., a subsidiary of the West End Consolidated Mining Co. The West End Chemical Co. thus becomes an active competitor in the borax market, along with the Pacific Coast Borax Co., the American Trona Co., and several other producing companies. During 1921 the Pacific Coast Borax Co.'s plant was shut down most of the year, and the American Trona, at its Searle's Lake property, operated only during the early part of the year, owing to restricted demand.

In common with other industries, the enameled-ware industry, which is the most important business utilizing borax, was depressed throughout 1921. Later in the year inquiries from this industry indicated a loosening of the situation, and it is expected that 1922 will bring a certain degree of prosperity to the borax producers.

The price of borax in the latter part of 1921 was approximately 5c. per lb. Exports during the first eleven months of the year were 3,658,059 lb., of a value of $246,658, as against 14,003,239 lb., of a value $1,171,651, for the corresponding period of 1920.

## The Fluorspar Industry

BY BENEDICT CROWELL
President, Rosiclare Lead & Fluorspar Mining Co.

THE fluorspar mines in the Illinois-Kentucky district, where about 85 per cent of the domestic output is produced, were practically idle during 1921. Total shipments will probably not exceed 25,000 tons, or less than 10 per cent of the 1918 output and about 20 per cent of the average pre-war production per annum over a period of five years.

The steel industry consumes approximately 85 per cent of the fluorspar produced. Stocks on hand at the close of the war, supplemented by later deliveries of tonnages contracted for on a basis of war-time produc-

tion, together with drastic curtailment of steel operations late in 1920, combined almost to eliminate purchases of fluorspar in 1921.

Fluorspar is essential to the basic open-hearth steel process. Prior to the war about 35 per cent of the furnaces were of that type. The ratio is now 80 per cent, as practically all new furnaces and replacements built during the war period were of the basic type. With reasonable activity in the steel industry and increasing demands from the glass, enamel, and other trades now using the high-grade ground ore, the outlook for 1922 is fairly encouraging.

It is not generally realized that the known fluorspar deposits of this country are very limited in extent. War stimulation failed to develop a single new orebody of consequence that I know of. The increased supply in 1917 and 1918 came from the exhaustion of reserves at the principal mines, depletion of all old and newly located shallow deposits, working over old dumps, and salvaging the low-grade ore left in the old workings of abandoned mines. Prices of $35 to $60 per ton justified extreme activity.

Only four producers in the Illinois-Kentucky district have railroad connection. The rest are compelled to haul the ore and supplies from four to fifteen miles over dirt roads that are almost impassable for five months in the year.

During the war period many new companies were organized to develop and operate fluorspar prospects. Practically all used up their capital and passed into history. Many of them never actually produced a car of ore.

Exhaustion of shallow deposits, the uncertainty and added cost of deeper mining, necessary exploration, and dead work are contributing factors which have tripled the cost of producing fluorspar. It has become a complicated, expensive, and relatively deep mining proposition. If the steel industry and other users in this country are interested in insuring a future supply of this material, the foregoing facts should be given serious consideration, and the ore should be valued accordingly.

# The Graphite Industry

By Benjamin L. Miller

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DURING 1921 the graphite industry of the world was in the most deplorable condition in its entire history. The present situation can be definitely traced to a few definite causes. The demand for crucible steel for war purposes created an unusual demand for graphite crucibles, and scores, perhaps hundreds, of new graphite mines were developed in Ceylon, Madagascar, the United States, Canada, and other less important graphite countries.

The sudden ending of the war found the steel manufacturers with large supplies of crucibles on hand, the crucible manufacturers with an excessive amount of graphite in stock, and the graphite-producing companies with supplies of refined and crude graphite sufficient to meet even the inflated needs of war time for many months or even for years. There has not yet been time enough to exhaust the surplus, and until that is done stagnation of the entire industry is the natural result. Prices have fallen, and there have been many forced sales at figures far below the cost of production, but even at a sacrifice it has not been possible to dispose of surplus stock.

It is a question as to whether the domestic flake graphite producers can successfully compete with the Ceylon producers, whose product is considered superior for crucible manufacture, or with the graphite producers of Madagascar, where a flake graphite similar to the domestic variety is put upon the market at lower costs than have ever been realized in this country. Congress is therefore being asked to impose an import tax on foreign graphite, to keep the American graphite producers from complete liquidation.

If it should become the policy of our Government to impose a temporary protective tariff on such of our mineral products as we have in great quantity until opportunity had been given to determine the ability to compete with foreign materials, graphite is certainly one of the minerals that should receive especial consideration. In Alabama, New York, Pennsylvania, Texas, and in several other states there is sufficient flake graphite to supply all our needs for centuries.

The alternatives are for the graphite producers to so perfect their refining methods that with decreased transportation rates they could compete in our markets with the foreign materials, or for the producers to engage in the manufacture of graphite articles. The latter is regarded as the only satisfactory solution of the problem by some of those engaged in graphite production, but as yet only one important company has made the attempt, and that organization produces only a small part of the material consumed in its manufacturing business.

Until supplies on hand are consumed, the production of graphite will be at a minimum in all countries, and practically all the mines and mills will be idle; but eventually new supplies must be obtained, and prices will depend upon the cost of production. The present situation is discouraging, but the future offers more promise, and it is hoped that, irrespective of an import tariff, the better-established American producers may be able to continue.

# The Magnesite Industry

By R. W. Stone*

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THE domestic production of crude magnesite in 1921 was between 35,000 and 40,000 tons, as compared with 300,000 tons in the preceding year. It came from California and mostly from two producers. The California product is employed largely for plastic purposes, and its use decreased in 1921, largely because of general business depression and restraint in the building trade, until in December all California magnesite mines were shut down.

The mines in Washington, which produced 220,000 tons in 1920, have been idle for twelve months, because their output was used exclusively for refractory purposes, and the steel business has been bad. Furthermore, the high price of magnesite has made steel companies search for a substitute, and it is surmised that figures eventually will show that the use of dead-burned dolomite for lining steel furnaces has greatly increased in the last two years.

Imports of magnesite can scarcely be charged with

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the slump in the domestic industry. The normal consumption of crude magnesite in the United States is about 300,000 tons. In 1920 it was 366,000 tons, of which 63,000 tons, or 17 per cent, was imported. The general imports in the first ten months of 1921 were 51,215 tons, and for the entire year will just about equal those of 1920. It would seem, therefore, that the demand for refractory magnesite in the United States is rapidly decreasing. Of the 51,000 tons imported, 31,000 tons was shipped from Italy, 8,000 tons from Greece, and 6,000 tons from Austria. Most of the magnesite imported was crude. In the first nine months of 1921, imports for consumption were 42,324 tons crude, valued at $9.75 per ton, and only 5,261 tons was calcined, but this was valued at $34 per ton. The low cost of production in Europe can be judged from the fact that the 6,000 tons from Austria in August was valued at port of shipment at $6.75 per ton. Italy shipped 6,000 tons in May, valued at $7 per ton, and 2,900 tons in October, valued at $8.90 per ton.

The present rate of exchange, the low cost of production in Europe and of water transportation, and the fact that the market for dead-burned magnesite is practically all east of Chicago combine against the producer who wishes to ship Washington magnesite to the Eastern market. The deposits near Chewelah and Valley, Wash., will constitute a reserve unless a new market west of Mississippi River can be found. The large producers in California should scarcely expect to supply all the plastic trade on the Atlantic seaboard, but by using definite heat-controlled methods to prepare a superior quality of caustic calcined magnesite they may be able to hold the trade of most of the country.

# The Talc Industry

BY RAYMOND B. LADOO*
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THE talc industry in 1921 experienced a marked depression, in common with nearly all industries. The generally unfavorable trade conditions were further aggravated by the expansion of mill capacity which occurred in 1919 and 1920. This resulted in drastic price cutting and severe competition among producers for the small amount of available business. In some instances prices were cut below the cost of production. New operators in general found great difficulty in introducing their product, although in one noteworthy instance a new producer was able to run his mill practically to capacity because of the demand due to the superiority of his product. Competition proved too severe for some of the smaller companies.

The generally unsatisfactory condition of the industry was reflected in the imports of talc, which for the first nine months of the year amounted to only 44 per cent by tonnage of those for the corresponding period of 1920 and about 91 per cent of 1919, a year of low production. Toward the close of the year a Canadian producer dumped his surplus stock on our markets at a very low price. Thus the final import statistics will probably show an increase during the last three months.

The demand for talcs of various grades is, of course, dependent upon the prosperity of the consuming industries into which talc enters. The largest markets for Vermont talc are in the paper, rubber, and prepared roofing industries. The poor condition of the paper and rubber industries in 1921 caused a severe drop in demand for Vermont talc. The prepared roofing industry was not as badly effected, but even here demand was far from normal.

Much New York fibrous talc is used in paint, and as the demand for paint was fairly good, New York producers of talc were probably in a somewhat better position. Toilet grade talc is produced in quantity only in California, and California producers find their principal outlet for high-grade talc in the East. Heavy imports of low-priced high-grade talc from Canada, France, and Italy, and high transcontinental freight rates, combined with a lessened demand, made it almost impossible for California producers to compete in eastern markets.

The tariff situation is still unsettled, though the Fordney Bill, which passed the House of Representatives, is regarded as affording ample protection to the talc industry. This bill provided for a tariff of ¼c. per lb. on the crude, ½c. per lb. on the ground and 1c. per lb. on cut or sawed crayons, cubes, or other forms.

Despite the generally unfavorable condition of the industry, there were a few encouraging developments. For the first time the talc industry as a whole, through the Talc and Soapstone Producers' Association, embarked upon an advertising program. Though the publicity so far has been rather limited in extent, it is a very hopeful sign.

Return to normal conditions will probably find the talc production divided between fewer but relatively stronger companies. Few producers expect a rapid return to the unusually high production of 1920. Hence new mill construction will not be justified in the near future unless such mills represent a distinct advance in the art of milling, resulting in lower costs or better grades. Domestic production of talc of toilet grade depends primarily upon the extent of protection afforded by the new tariff bill, but is also influenced materially by freight rates and labor costs.

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# The Mica Industry

BY RUDOLPH S. LIENAU
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THE mica industry at present is at its lowest point for many years. Large quantities of imported mica are on hand, which are slowly being disposed of, while hardly any of the domestic mines are producing any mica of consequence. It is my belief that only 10 per cent of the firms producing mica in pre-war times are now operating.

This critical situation in the industry will remain until manufacturers using mica are working on a full-time basis, and depend again upon the production of domestic mica of sufficiently good quality and quantity and at a reasonable price to make it profitable for the consumer to use it.

With a little help from the new Fordney Bill, which places a tariff of 6c. per lb. on the imported mica, and which may become a law about March 1, 1922, the industry can again return to its former satisfactory condition provided the wage scale also returns to a reasonable basis.

The lack of modern machinery in the process of mining and the need of trained men who understand the mining and manufacturing of mica are the greatest handicaps in competition with the imported material.

# Industrial Efficiency

## Training Miners for Efficiency

### Standards of Work Must First Be Determined—Best Methods Evolved by Conferences — Foremen and Bosses Become Teachers — System of Reward For Accomplishment Essential — Increase of Earning Power Reduces Costs

BY ARTHUR NOTMAN
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THE GREAT WAR brought to the metal-mining industry what it brought to all war industries, the supreme necessity for greater production. The industry has reason to be proud of its response to the need. That it was accomplished at the sacrifice of costs is a matter too well known to require comment. Unparalleled surplus stocks, notably of copper, produced at high costs, and failure of demand since the Armistice, have resulted in the shutdowns involving lay-off for employees and reduction or suspension of dividends to stockholders.

The supreme necessity of peace is lower costs. Can and will the industries make the same splendid response to this even more important need? If so, how can they do it? The following factors control: Better management; better methods; better equipment; better-trained men.

I shall not attempt to evaluate these factors, and I have little to offer upon the first three. Perhaps it would be just to assume that the management which directed the doubling of production under war conditions is capable of directing the halving of costs under peace conditions. Better methods are a function of management and, likewise, better equipment. Having gone this far, one might easily close the argument by admitting that better-trained men are also a function of management, and they are.

#### SKILLED MINERS CALLED UPON TO DIRECT METHODS

Before the introduction of machine drills, with the tremendous increase of individual productivity in mining and the inevitable expansion in demand for mining labor, the miner was an artisan who had chosen his profession because of the romance in the search for buried treasure which by his skill and effort he might any day uncover for the world's enrichment. What he didn't know about drilling, breaking, mucking, timbering, and ore was not to be learned. The supply of such trained, skilled, interested artisans was adequate to meet the demand. What happened then? With the rapid expansion of the industry these same men were called upon to direct mining operations. They were placed in authority over large groups of practically untrained men attracted to the industry by the prevailing high wages. They were called on to direct methods and use equipment with which they themselves had had no previous experience. To their credit, let it be said that they made the best of a bad situation. With the help of the management, they carried on.

What has been done or can be done to improve this condition? Too many things to enumerate—in fact, so many that some are forgotten until brought to light in the cold gray dawn of returning competition.

Perhaps most of us have decided at some time or other that there was one best way to do a certain piece of work. We have issued an order that hereafter all such work should be performed in that manner. Straightway we have gone forth and forgotten what manner of order we issued. Months or perhaps years later, we were asked how such work was being done in our mine. Glibly we described our one best method, and very likely in the course of conducting our inquisitive visitor through the workings we found that same piece of work carried out in a different manner in every heading. Possibly we had never even regarded the question of how to do that particular job as of sufficient importance to reach the conclusion that there was one best way of doing it. We knew that our general plan of ore extraction was sound, that we had good equipment, that our foremen and shift bosses were well chosen, and that the men were the best that could be obtained. What more could we desire? If mining could be carried on above ground, perhaps nothing more would be required, but, unfortunately, in most mines, not over a half dozen men at the maximum are in sight at any one time while working, and the general average would be nearer two.

How can we overcome the fundamental difficulty in supervision? First, by increasing the number of bosses and improving their quality. Second, by reducing the number of methods. Third, by rewarding good work directly and promptly.

Some operators have reduced the necessity for increased supervision and have obtained excellent results by contracting all or nearly all of their work. I think the best field for such a method lies where uniform conditions maintain over large areas of the mine, as in certain coal and iron deposits. Some, fewer probably in number, have worked successfully on the straight day's pay method, with increased supervision. Others have adopted task and bonus schemes based on standards of performance satisfactory to both company and employees. This last seems the more elastic and consequently the plan best suited for general metal-mining conditions.

In choosing contracting as the lesser evil, one must be sure that standards are based on work done by good methods under good conditions and by good men, or no

saving will result. Under the day's pay plan, the same factors control, but with an added difficulty. There is no more incentive for the good miner to extend himself than for the poor one. This strains supervision to the utmost.

Under the task and bonus plan, properly applied, the mining company is assured that only better than standard work will receive better than standard pay. The miners are assured that they will receive nothing less than standard wages and that any work that they can do better than standard will be adequately rewarded. What do we mean by standard work? First, we must make a careful detailed survey of all methods in use and all other possible methods for doing each item of work. Second, we must select the mest method from the joint standpoints of safety and economy. Third, we must introduce that method to all foremen, bosses, and miners. Fourth, we must then instruct them therein. Fifth, we must see that these methods are followed.

After these details have been taken care of, we are then in a position to make records of the average performance by the standard methods under good supervision with standard wages. This is standard work. Only after this has been established can the question of bonus rates be discussed intelligently and the division of the savings, to be made by greater and more intelligent effort, both of management and men, be placed on an equitable basis. Important to the success of any such study are frequent conferences among all those who will be responsible for the instruction of the men, so as to secure the value of their knowledge, criticism, and suggestion.

Trained miners in sufficient numbers are no longer available, and must be developed by foremen and bosses who have ceased to be taskmasters and have become teachers and leaders. In fact, they will furnish most of the knowledge to be transmitted to the miners. A permanent committee on standard methods and permanent records available for distribution in the form of pamphlets describing these methods will be of great assistance in this program. A step further would be a course of study by foremen and bosses in the instruction of miners in standard methods. The plan cannot be too rigid, so that methods may be modified or discarded in the light of experience.

As a concrete example, standard methods for drilling, loading, and shooting development faces might be cited. Such methods have been described in C. A. Mitke's book on standardization, published a few years ago by *Engineering and Mining Journal*. Mr. Mitke's book was based largely on the observations of such a program then in process of development at the Copper Queen Mines of the Phelps Dodge Corporation at Bisbee, Ariz. These observations were made during frequent visits to that property as consulting engineer on ventilation problems.

Nothing has yet been found so generally productive of results in opening the minds of men to new ideas as the hope of reward. Any time that a man can be shown that by using new methods he can increase his earning capacity, you gain his prompt attention. If you attempt to show him this without any other object than advancing your own interests, you fail to get under his skin. If you merely order him to do things your way, the burden of seeing that he does so remains on your own shoulders. Your sole reliance then becomes his fear of losing his job. Though such fear may be wholesome for us all at times, it cannot be upheld as the only or most desirable incentive to human effort. Herein lies the hope for better-trained miners.

In my college days there was much heated debate over the respective strokes in use by our own and our rival university crews. I shall never forget the feeling of utter conviction with which I heard one intelligent student of this question deliver himself of this piece of common sense: "A poor stroke well rowed will beat a good stroke poorly rowed seven days in the week." Though this is no argument for poor methods, it does exemplify the need for good training and sound morale.

How can these be secured except through the efforts of our foremen and bosses and a system of reward based on accomplishment? We must train our foremen and bosses in their obligations as teachers. We must study what we want them to teach. In doing so, we must invite them to furnish their contributions. We must then open the minds of their men by paying for work and not for time. It can be done because it has been done. Metal miners would be well repaid by a survey of the many successful applications of these principles in other industries as well as in their own. There have been failures, and there will be more so long as greed outruns common sense and justice. Individual bargains are good only when they are good for all three parties. Why talk to me about efficiency and loyalty when, if I furnish them, you take all the profits. Show me how to increase my earning power and I will show you how to reduce your costs. This is a good bargain for miner, mine owner, and consumer.

# Standardization in Mining

## A Plea for Systematic Classification of Underground Conditions—Study of Methods an Essential Preliminary to the Selection of the System Best Adapted to Existing Conditions—Standardization Not Permanent, But Changes When Better Methods Are Developed

BY CHARLES A. MITKE
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THE NEED for investigation of mining practices, or mining methods, with a view to improving present conditions in respect to high production costs, has made itself felt throughout the entire mining industry.

Not long ago, the standardization of metal-mining systems was considered impracticable, particularly underground operations, from which natural circumstances have, to a large extent, excluded the light of publicity. The reserves of many of the larger mines were also so rich and extensive that economy did not play as important a part as perhaps it should have done. In addition, the ever-present possibility of "sweetening the ore," or, in other words, bringing the

daily output up to expectations by the addition of high grade, kept in reserve for such purpose, has often tided over situations which otherwise might possibly have disclosed unsystematized methods and careless supervision on the part of underground bosses, to whom the necessity of making a showing at the moment, by producing a large tonnage, meant everything, regardless of the disastrous effect their methods might have upon the future of the mine.

Now, however, the situation has changed. The mines are confronted with the possibility of having to operate on a small margin of profit with wages somewhat reduced, and with costs of materials, supplies, and all necessary materials and equipment still considerably above pre-war prices. Moreover, the richer orebodies are being rapidly depleted, leaving the leaner ores, which require more economical methods of mining.

### Future of Metal Industry Dependent on Cost Cutting

Many writers have expressed the opinion that the future of the metal industry is largely dependent on cost cutting. This gives rise to the question, "How and where shall costs be cut?" Supplies and materials are still higher than pre-war figures; labor is as high—in some districts higher; freight rates are also high. How, then, are we to meet the situation?

By an analysis of every detail connected with the various operations in mining, followed by a systematization or standardization of operations; by training the men to perform their work in the most efficient and modern manner; by substituting mechanical devices for human labor wherever possible; by the use of improved mining methods; by keeping a careful accounting of every item of expenditure; and by a healthy agitation for better and improved mining equipment, which will stimulate further experimentation on the part of inventors and manufacturers.

As stated in a recent editorial in *Engineering and Mining Journal*, "the economy resulting from consistent study of the details of mining is in the aggregate large. Isolation and excessive conservatism are probably in a measure responsible for the slowness to take advantage of the progress that is being made." The question has frequently been raised as to how far standardization underground can be carried. At present there are so many opportunities for standardization in this field that it is well to test its possibilities before we consider its limitations.

*Standardization of Mine Timbers.*—The standardization of mine timbers, as far as it has been perfected, has given such encouraging results that investigations are now being conducted for standardizing timber details still further. Chutes, raises, manways, drift sets, and tunnel sets have already been standardized in a majority of operations, so that it may be said that approximately 50 to 90 per cent of all the timbering used underground conforms to certain standards.

*Standardization of Drilling Machines*—The mining industry is at present burdened with a multiplicity of machine drills of varying types, sizes, and weights, the difference in weight between machines in some instances being not more than 1 to 2 lb. The introduction of new machines is so rapid that in an effort to stock up with the best equipment available on the market, many machines in good condition must be scrapped, and as minor parts are not interchangeable, a considerable expenditure in such supplies must continually be charged off to profit and loss. The development of these machines is, of course, effected by the manufacturer to meet the needs of the industry, but, unfortunately, these needs are often the individual conceptions of various operators rather than the combined views of the majority. What may appeal to one does not meet the need of the other, and consequently, the necessity for purchasing and trying out this variety of types becomes an ever-increasing burden on the operator. Were there any great difference between the types, there would be a considerable advantage in this vast experimentation on the part of the operator, but often, as stated before, the difference is so slight, perhaps an increase or decrease in weight of one pound, that the advantage gained is almost negligible.

### Analysis and Classification of Conditions

*Classification of Underground Conditions*—In the standardization of drilling machines, the first requisite is the classification of underground conditions and the recognition of the types by the operators. This might appear to present difficulties, but such is not the fact. The Copper Queen standard rounds were based on a classification of the ground. There were different types of rounds for different kinds of ground, and these rounds are now universally used in the various mines in the Warren district. The same is true of the company bonus system, which is also based on a classification of the ground. After all, the manufacturer himself, in selling his machines, actually bases their value to the operator on their guaranteed performance in certain classes of ground.

Although the argument is being continually advanced that "conditions in every mine are so very different," by which is meant that the types of ground are entirely different, this is often overdrawn. As an example of the extent of this erroneous impression, consider two mines, side by side, mining the same orebody and with the property line going through the center. The mine on one side of the property line adopted a small 45-lb. machine, and had excellent success with it for years, whereas the mine on the other side of the line, in the same orebody and with exactly the same conditions, used a 125-lb. machine with large steel, the operators giving as a reason that "conditions were so very different that the small machine was not applicable in their kind of ground." After some years, they were persuaded to make extensive tests with a small machine, weighing about 45 lb., and small steel, and were surprised to find that it did just as well in their mine as it had done in their neighbor's. Though conditions in mines in general are, of course, not as similar as they are in these two properties, there is not as much variance in rock conditions as men who are familiar with only a few mines would have one believe.

Should a survey be made of a large number of mines, and the different classes of ground be listed (after the duplicates had been omitted), it would probably be found that, with few exceptions, a dozen general headings would cover the different classes of ground found in practically all mines.

Therefore, the first step in the standardization of rock drills is a classification by the operators of their own underground conditions. When this has been done, and the conditions have been designated by certain

specific headings, the next step is a comparison of the performances of different weights of machines in the specified kinds of ground. From this comparison the weights and types of drilling machines that will suit each class of ground, or combination of classes of ground, can be determined.

*Drilling Machines*—An incorrect impression still prevails as to what "standardization of drilling machines" entails. It is not suggested that operators should draw up detailed specifications, covering the most minute points in the manufacture of rock drills, or select one certain rock drill, prohibiting all further improvement; but, rather that, having first classified underground conditions, and unanimously agreed upon the best approximate weights and types of machines to meet those conditions, the operators should then ask the manufacturers to concentrate their efforts on constructing and continuing to improve machines of those weights and types to meet the specified conditions. In this way, the large number of different types, sizes, and weights of machines now on the market would ultimately be reduced to a comparatively small number, and the manufacturers would then be able to devote all their ingenuity, skill, and inventive genius toward improving this small number of machines.

At present, progress in the standardization of rock drills is at a standstill. An obstacle is that competition in the rock-drill business is so keen that the manufacturer is compelled to sell first-class, high-grade, machines almost at cost. The margin of profit on the machines is so small that he is forced to take the larger portion of his profits through the sale of minor parts, the cost of which is excessively high.

By minor parts is meant such accessories as cradle, feed screw, and side rods, but not the major parts, such as the rock-drill engine proper, patents on which are the property of the manufacturers, and which parts should not be included in the standardization program, for the reason that it is to the benefit of the industry to stimulate further experimentation and improvement in the building of such major parts. The interchangeability and standardization of minor parts would, of course, greatly reduce the manufacturers' sales, and naturally his profits, and consequently he does not accord much enthusiasm to propositions promotive of that purpose. On the other hand, minor parts for drilling machines not being interchangeable, and practically every variation of drilling machine requiring a different set, the operator is compelled to spend large sums of money on such parts, which become obsolete as soon as he purchases a different type of machine. This expenditure is so large that, at many properties, old, out-of-date machines are kept in operation much longer than they should be, so as to use up the replacement material on hand, which otherwise would have to be scrapped as useless. Were the minor parts standardized, as suggested, and interchangeable, it would then be possible for the companies to eliminate their old machines as soon as their efficiency dropped, without at the same time entailing a great loss through the scrapping of parts which would fit no other machine.

*Standardization of Chucks*—The standardization of chucks for machines should keep pace with the rapid standardization of drill steel. Formerly, six or seven different kinds of steel were used at many mines where today it is unusual to find more than three, in some operations only two, and in exceptional instances one kind of steel at a mine.

*Drilling and Drill-Sharpening Operations*—A great deal of work can be done and is being done in the standardization of the various operations connected with the sharpening and tempering of the drill bit. Many mines have also already done much toward the standardization of operations connected with drilling, such as the working out of standard machine rounds and the establishing of a routine for the driller. This practice will find a still wider application to mines in general when the operators have once got together and have classified their various kinds of ground, and decided on a minimum number of types and weights of drilling machines.

*Shoveling and Loading Underground*—One of the great needs of the industry is the use of a mechanical device in place of hand shoveling. The perfection of underground mechanical loading machines, followed by the standardizing of operations connected with them, will solve this problem; also, changes in the stoping methods, such as the liberal use of incline raises; the carrying up of much smaller stopes in high-grade orebodies, which will permit the use of slides to the chutes; and the substitution of incline square sets, incline top-slicing, and incline cut-and-fill for the horizontal methods.

*Sampling and Estimation of Ore Reserves*—When it is desired to compare the ore reserves of one mine with those of another, the first difficulty met is the determination of the methods that were used in sampling and in computing the ore reserves. The personal element frequently enters into the calculations. The working out and adoption of certain standard methods of sampling, and of estimation of ore reserves, would be of great value in computing and comparing the orebodies of one mine with those of another, in respect to the ore in sight and the tonnage extracted.

*Mine Accounting Systems*—Comparison of underground mining costs of various companies is at present practically out of the question. Every company has a different set of items which go to make up its cost sheets. For instance, one company will charge the preparation of a stope to prospecting and development work, whereas a second company will include it in the stoping cost; another company will charge the tramming of ore to stoping, and still another will include it in its transportation charges, and so on. Few if any organizations use the same system, and therefore their costs are valueless for comparative purposes. The working out by first-class mine accountants in conjunction with competent mining engineers of a standard system of cost accounting for underground mining, which would meet the conditions of a majority of the mines, and include the same items, would be of immeasurable value in stimulating healthy competition, and would give rise to investigation by those companies which, after comparison, found that certain of their costs were high as compared to those at other properties. Unquestionably such comparisons would result in lower costs at many mines.

### Miscellaneous Underground Operation and Training of Workers

*Other Units of Underground Operation*—In addition to the specific instances already mentioned, standardization can also be applied to the routing of sharp steel from the shops to the underground workings, and dull steel from the working places to the surface. The same applies to the routing of mine timbers. The

standardization, also, of the materials for underground warehouses; ventilating equipment for drifts and raises; ventilating doors; fire-fighting equipment, to be kept on hand for immediate use; mine cars, locomotives, track, gage, rail, and other materials and routine operations is worthy of consideration and deserving of extended study.

*Training of the Workers*—After having worked out and introduced standard methods wherever practicable in mining, it is then necessary to train the men so that they may perform their work in accordance with the standard practices.

*High Costs in Absence of Standardization*—It has been my privilege during the last year to visit, among others, some mines in which no attempt has as yet been made at standardization. Practically every stope was carried up in a different manner. Nearly every raise, drift, tunnel, chute, or manway had some individual feature about it, which the members of the organization characterized as "additions, possessing certain advantages over the previous cases." In summing up the situation, these mines, in which no standardization was attempted, might be characterized as "great mines worked by hand methods." The mining costs told the story, as they were 50 to 200 per cent higher than those in mines of similar character where standardization has been introduced.

There is, I find, considerable misunderstanding regarding the general scheme of standardization in mines. A great many, even in the operating field, still believe that standardization means the selection of a few types of machines and certain methods of operation, which, once adopted, are to be used continuously without change, which procedure, if followed, would naturally limit experimentation and retard progress. But those who advocate standardization in mining contemplate no such outcome. The selection of a piece of standard equipment, or a certain method of performance, implies only the adoption of that which, after careful consideration, appears to be the best machine or practice available at the time. When better equipment or better methods are offered, and careful study proves beyond a doubt their advantage over those in use, the older equipment and methods should be replaced by the newer and better things.

As Tennyson says, "The old order changeth, yielding place to new," and such has been the history of the world from time immemorial. Why, therefore, should any attempt be made to stop the hands of the clock of progress in respect to standardization of mining?

# The Reduction of Costs

## Average Prices and Costs Expected To Decline Gradually—High Wages and Short Working Week Destroy Efficiency—Stabilized Figures, Based on Supply and Demand, Better Than High Prices

By J. R. Finlay
Mining Engineer, New York

THOUGH ONE MAY EXPECT rather confidently that the average price and cost of commodities, measured in gold dollars, will decline for the next fifteen years or so, it is probably not reasonable to anticipate that they will decline uniformly. In many directions the fall in prices has been overdone; in others it has hardly begun. Thus, though the tendency is certainly downward, we shall undoubtedly have many instances of increases of prices of commodities that have slumped unduly, if only to regain some balance with commodities that have remained at war levels. It is hardly too much to say that from the viewpoint of many producers we have not yet obtained a readjustment of prices but rather a maladjustment. For example, before the war, and even during the war, a pound of copper in New Mexico would buy over 200 lb. of run-of-mine coal; now it will buy only 60 lb. So many examples of this kind have been cited that it seems useless to repeat them.

### Preference for Urban Living Conditions Creates Difficult Problem

So far as one may judge from the comments one reads and hears, it seems that the public has discovered the chief obstacles in the way of a more equitable scale both of prices and of costs in fuel, transportation, and city house rents. Of the last probably it is enough to say that the high rents result from an under-production of living accommodations. I have said "city house rents"—in the small towns and in the country there is no apparent shortage of room. Back of the shortage of house room in the cities one must explain why so many people wish to live in the cities. This I shall not attempt, but merely mention it as one of the prime causes of the economic maladjustment.

The abnormal price of fuel and transportation certainly finds no support in under-production. On the contrary, those commodities can be oversupplied by 40 or 50 per cent. The true explanation lies in preferring artifice to nature, building up an economic scheme which nature does not approve of and will certainly destroy. The Government boards, in deference to labor unions and according to their lights, always with the attitude and solemnity of devotion to equity, have built up such inequalities that it is not hyperbole to call them grotesque.

### Coal Mines in New Mexico on Two-Day Schedule

On a recent trip through the coal fields of New Mexico I found that the mines were working about two days a week. There was labor enough and development enough at hand to produce two or three times as much coal as could be sold; or, conversely, from one-half to one-third either of labor or of mines could supply the market. But at the same time the cost of production was the highest on record. The operators were having the greatest difficulty to make both ends meet, although run-of-mine coal sold at nearly $4 a ton and lump coal at $6.75 at the mines. It cost one of the principal operators $17.16 per man per day to run his mine for the month of September. Mexican laborers all over the state get $2 a day—sometimes $1.50. In the copper mines of the

south they get $2.10; but in the coal mines the same Mexicans get a minimum of $7.90 per shift. The average of the diggers is a great deal more.

Shaft miners in Arizona get $4.50 a day; in these coal mines $8.40 plus a bonus. In the only two shafts being sunk, the work is done by miners from the copper country on these terms, in this kind of competition with the copper industry and the agricultural industry, both of which need cheap fuel more than at any time in their history. If these prices resulted from scarcity with an overpowering demand to force production, no one could, within reason, oppose objection. They would be temporary. The proper forces would be at work to restore equilibrium. But they respond to nothing except the pure inertia of price fixing. These wages were fixed by the award of one of Uncle Sam's boards for price fixing, I forget the name of it, and the wages are supposed to stand until April 1, 1922.

### High Wages and Short Working Week Destructive of Efficiency

To show how well rooted these prices are in economic necessity, I found at a wagon mine a hundred miles from the railroad excellent lump coal selling for $2 per ton. It was hauled fifteen miles and delivered at the house in Farmington at $5.50 per ton. The coal was dug by a miner from West Virginia, and the farmers of the neighborhood took little stock in labor unions.

I thought this exhibit was particularly instructive in the patent fact that though these artificial prices did everybody harm, they did nobody any good. The number of beneficiaries was infinitesimal. The highly paid miners get $15 to $25 per week, if they are lucky; but, in the excessive prices caused by their excessive wages, they do well to keep body and soul together. Their surroundings are ash heaps and tin cans, a sure proof that their days of idleness are an exercise in shiftlessness. Their children have the outlook of tin cans and ashes, with loafing on the street corner as a luxury in prospect for a real man.

### Competition Actually Profitable

Through all this the people seem to be learning that competition is actually profitable; that to protect any class of people from it results in making them poor—an artificial scale of wages in excess of that warranted by production is either charity to mendicants or a tribute to robbers.

I have always believed that to pay higher wages than your competitor is good business, because thereby you generally get better men, with increased production, even more than in proportion. A man's plant costs money. It requires more capital to provide equipment for a thousand poor men than for five hundred good ones. But the most casual glance at the record of coal production in New Mexico is enough to prove that every cent that has gone to raising wages has gone to increased cost. There has not been the slightest increase in production; rather a decrease per man. The country therefore is burdened with an immense increase in the cost of fuel, for which there is no compensation whatever —except experience.

The break-up of the economic absurdity which I have described has, however, already begun. Wages have been cut in Colorado, and prices of coal have been cut already in New Mexico. The reduction all round will no doubt sweep the country, and before the end of 1922 fuel will probably be had on a normal scale of prices.

I have dwelt on the coal situation particularly because that, with railroad transportation, is an example of Government interference with production. It is nothing less than that. It is truckling to the bugaboo of trades unionism; but of course it masquerades in the pretense of fair play to the poor laboring man. In other industries that are free from this pious scheme of lifting oneself with one's boot straps there is a marked difference. Readjustment has gone on apace. In contrast to the stagnation of production in the Government-protected coal mines, I can name instances where the output per man has been raised during the past year more than 50 per cent. The lead mines of southeast Missouri are an example. In these mines, despite the fact that the high cost of freight, fuel, and supplies still keeps the cost of lead above the pre-war level, the efficiency of labor has returned to a marked degree, production per man is much higher than before the war, and the business is on a firm basis. The men are earning far more, though at a rate of wages nominally lower, than the coal miners.

Except for the cost of power and transportation, the metal mines of southern New Mexico and Arizona can operate as cheaply now as they ever could. The gold and silver mines of this region are rather far apart, but as the matter of transportation with them is of less consequence than with other kinds of mines, they are operating successfully. Their costs, in some instances at least, have got down to pre-war levels.

In general, I think we may say confidently that except where labor is suffering (that is the word for it) from the false economics of unionism and Government control, it is as efficient and productive as before the war, which so greatly disturbed the normal progress of events.

### High Prices Do Not Indicate High Profits

One very interesting fact is disclosing itself. High prices are not a sign of high profits. From 1917 onward, the profits of metal mines declined with the same rapidity with which they had previously risen until for the years 1919 and 1920 those of New Mexico all showed a loss. In the coal mines the profits show an increase if measured in dollars but a decrease if measured in any other way. The proportion of profit to gross value of product has been uniformly less during the era of high prices than it was before the war, and the purchasing power of those profits has been less, with the same uniformity.

It seems to me that this fact brings home an exceedingly important economic lesson. It is an old story that there is no merit in inflation. Somebody always gets hurt, but even sensible men have generally preferred high prices. The fact seems to be that abnormal prices, either high or low, indicate an economic disparity from which a large section of the population must be suffering. People are wasting their efforts; working in vain; either producing what is not required or failing to produce what is required.

To keep exchange flowing freely, with everybody producing, so that each person may supply his needs with the greatest ease—that is prosperity. Stabilized, or fair, prices—prices made stable by the solid facts of supply and demand; by demand justified by ability to exchange goods for goods, and supply justified by competitive production—are far better than high prices, which either represent the exploitation of other peoples' necessities, or are fanciful and illusory, measured in dollars that are degenerating into scraps of paper.

# Promoting Efficiency in Drilling Ore and Rock

## Present Conditions in Mining Require Adoption of Preferred Methods in All Operations—Drill Carriages—New Drill Column Mountings—Standard Rounds —Better Rock Drills—Co-operative Research Necessary for Improvement

By B. F. Tillson
Assistant Superintendent, New Jersey Zinc Co.

MORE THAN EVER before the mining industries are feeling the urge for a greater productivity per unit of labor because of higher prevailing wage scales. As it is improbable that these will return to the pre-war base, and as it is likely that competition will be keener in the future, all operators are, therefore, strongly prompted to consider all means of increasing efficiency.

The mining industry is peculiarly in need of such help, because of the restricted market and low prices now current for its products and the insistent demand for still lower prices. It is obvious that a reduction in costs purely on a wage-scale basis will not produce the results which are sought, for such a step could not be taken in the mining industry unless it were correlative with a similar movement in other industries. It therefore appears that an increased efficiency must be sought, even though wage scales drop toward the pre-war rates. Mining work must be carefully analyzed into its component operations and into the fundamental ways in which efficiency may be increased.

The art of mining may be divided into such elements as drilling, blasting, timbering, mucking, loading, tramming, mechanical haulage, hoisting, pumping, power, and concentrating (and these groups may be further subdivided). This paper will consider only the first element, which is an important item in all cost sheets.

The productivity of labor units may be increased by the development of methods of working which minimize wasted energy or useless motions; the installation of machines of a high rate of productivity; and the establishment of contract, piece rate, or premium systems to give the laborer a greater incentive.

### Methods of Working

In drifting operations, it is preferable to provide two headings for each group of drill runners and muckers, so that the operations of drilling and mucking may occur on alternate shifts in each heading and the work of neither group of men will impede the progress of the other. The runners will then not be required to muck out a place in which to set up their drill columns (this being a useless handling of muck and additional time), and the muckers will not be called upon to pack drill steel or otherwise wait upon the runners and will not have to handle muck beneath the feet of the former. Where the time of progress of a heading is the item of importance, this desirable arrangement is not possible, and it then is necessary to seek other methods to reduce the interference of the two groups.

To avoid useless mucking on the part of the runners and to get the rock drills working as promptly as possible after the beginning of the shift, it is advisable to discard the vertical drill column in favor of the horizontal drill bar. The set-up of the latter may be greatly facilitated by the use of a tunnel carriage such as that shown by Fig. 1. Such a device may be constructed at any mine. The cantilever arm is made of a length sufficient to reach over the muck heap to a point where the bar can be jacked into position. If the drift is not a narrow one, the carriage need not be taken away from the heading after jacking the crossbar, but may be left attached to it, as the muckers will have room to work around and beneath the arm. As the arm, cross-bar, and drills are counterweighted by a sheet-iron box filled with heavy ore or iron castings, it is possible for one man to control the elevation of the equipment by means of a hand wheel working on a discarded feed screw. A

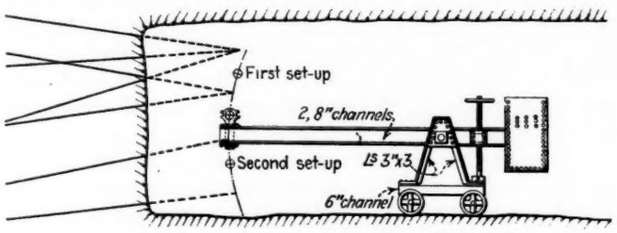


FIG. 1. DRILL CARRIAGE USED IN ADIT CONSTRUCTION

swivel socket for the bar at the front end of the arm may be made from a drill column arm, and its clamping cap will permit the cross-bar to be adjusted laterally to the cantilever arm.

### Correct Mounting of Drills

The rock drills may be mounted directly on the cross-bar or may be mounted sideways on column arms which are mounted vertically on the cross-bar, thus giving a greater latitude for placing holes from any position of the cross-bar. Years ago, four 3¼-in. reciprocating rock drills were operated successfully with such a mounting in a tunnel 11 to 12 ft. wide and 9 ft. high. In that operation, the drills were all connected by short lengths of 1-in. hose to a 2-in. pipe which ran through the counterbalance box, and a 2-in. hose was used to connect to the air line, so that only one air connection was necessary to make the drills ready to operate. The drills and cross-bar were always in position on the tunnel carriage, and when the heading was drilled up the jackscrews were loosened, the cross-bar was swung around parallel to the cantilever arm, the 2-in. hose disconnected, and the carriage run back along the track to a place of safety—a great economy of time and labor over the usual routine of disassembling and carrying a number of heavy pieces by hand.

In drifting, the rock-drill saddle and clamp is usually mounted on an arm, especially where a vertical column is used, and this arm is almost universally a casting of a fixed length which is clamped upon the column so that its axis will intersect the axis of the column. It is usually desirable that this arm should be of such length as to permit the column to be mounted in the center of the heading and yet allow the drill to be placed against

the side walls when swung to either side. But as there is often a variation in the width of drifts, the result is that an arm is used which is too short, and either the side holes are drilled with too much spread (thus necessitating extra holes, "easers," using extra explosives and breaking unnecessary muck), or an extra set-up of the drill column is required. This type of mounting should be abandoned, in my opinion, in favor of a special cross-clamp (see Fig. 2) in which a pipe arm is fastened approximately tangent and at right angles to

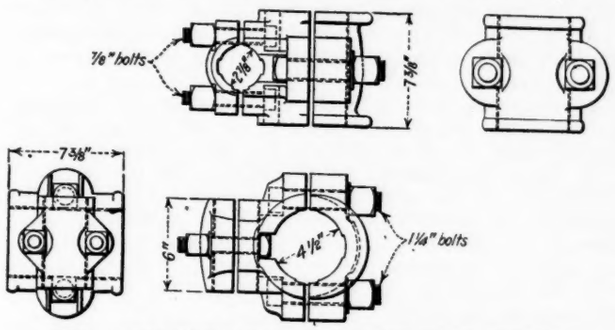


FIG. 2. COLUMN ARM CLAMP FOR ROCK DRILLS

the drill column. This pipe arm should be of a length more than half the width of the usual heading, as its effective length may be readily adjusted by sliding it through the cross-clamp. It is also feasible to make this arm almost as long as the width of the heading, so that two drills may be mounted on it and the holes can then be planned in such a sequence that one machine would finish its side holes before the "easers." The arm could be shifted laterally through the cross-clamp, so as to permit the other machine being positioned for its side holes. Such a cross-clamp permits a mine to be equipped for drifts of various widths without carrying a reserve supply of the heavy cast arms of various lengths, providing it carries pipe suitable for making the pipe arms.

For the heavy hammer-drill type of drifting machines, it is advisable to use 4½-in. outside diameter columns made from 4-in. extra heavy pipe, as smaller and lighter columns permit too much axial and torsional spring; but the arms can often be 2⅞-in. outside diameter made of 2½-in. extra heavy pipe. This decreases the weight of the arm and saddle clamp, which must be lifted by the runner with his machine when changing its elevation on the drill column.

### STANDARD TYPES OF ROUNDS

At each mine experiments should be conducted to determine what standard types of drifting rounds should be developed to meet best the various conditions of ore, or rock, and of mounting. The problem is to insure that the standards are properly applied. Different operators have developed specially graduated cones or column fittings to indicate the angular direction of the drills horizontally and vertically, or have applied clinometers, protractors, or templates for the same purpose. However, have not these devices been largely of educational value in training the drill runners to realize the proper positions of their drills, and, once they have learned, is it not possible for them to measure the relative location and direction of one hole with another with no other instrument than a folding rule, by which they can estimate closely the proper spacing, convergence or divergence of the holes? It has been the experience of some that such accessory devices were only of temporary necessity and use, although of value in instituting the "blueprint" drill rounds.

It is of fundamental importance that in planning a round there should be no attempt to make it of greater depth than will permit of its being drilled and blasted by a crew of men working one shift, with possible overtime. This places the work on a unit task basis and obviates the tendency to "soldier." If the round is planned so that it requires work on a shift following its start, it is only reasonable to expect that the drill runners will run into enough difficulties to require virtually the entire second shift to complete it, or the remainder of the time available on the second shift will not be profitably spent because of the presence of powder smoke in the heading during regular working hours or because of the time lost in transferring the men to other work. Again, it is preferable not to divide the responsibility for the breaking of any round as would be necessary if another crew of men had to finish drilling and blasting it on the following shift. Where the task is a little too great to be completed in one shift when the runners must set up their columns and machines, it may be possible to overcome this difficulty by training the muckers on the opposite shift (where alternate headings are drilled and mucked) to set up the columns and machines, so that the runners then find it possible to drill up the round and blast in one shift.

### EXTENSION POINTERS ON STOPERS

In raises and stopes where the air-feed stoping drills are used, it is possible to have a type of mounting not generally appreciated. This additional device is an extra extension pointer which slides within the direct air-feed cylinder and is locked by a gib and key wedge, cam, or various other devices. The only objection to this attachment is its weight of 7 or 12 lb. On the other hand, it permits an additional extension of the drill of 24 to 28 in., which permits the final drill steels to be run into the rock their full length without the use of a pile of blocking beneath the feed point (and oftentimes the use of such blocking is a hazardous and time-wasting practice). Also, if the extra extension pointer is partly extended when a hole is started, it is possible to use drill steels whose lengths vary considerably from the usual tolerances in a set, and the saving in steel which would otherwise be cut off in the blacksmith shop to change it to the next shorter standard length, when it has worn too short for its original length, may be great.

An economy in labor also results in the omission of a length of drill steel from the set, if it be broken or battered. It is therefore unnecessary to delay the work while a search is made for a steel of suitable length. This is possible if the extra extension pointer is retracted into the feed cylinder so as to permit this insertion of a longer drill steel. In raises, in addition to the foregoing advantages, the extra extension pointer permits the staging to be mounted on timbers wedged into the old bottoms of drill holes, regardless of the fact that they are slightly further from the face than would normally be desirable. This saves the time and labor which would be required to cut hitches or avoids the decided hazard of mounting a stoping drill on a pile of blocking on the staging. The extra extension pointer is strongly recommended for investigation by mine operators who are desirous of increasing the efficiency of their pneumatic-feed stopers.

The remarks already made about arranging a task

in drifting which will be completed in a shift apply as forcefully to raising, but if two raises are available for a crew to work in, it is sometimes possible to get the same men to break a round in each raise within an eight-hour shift, especially if one of the two men does some work in the second raise when his pardner does not need help.

### Better Rock Drills

The buyer must be discriminating, so as to encourage the manufacturer in the development of superior tools. Therefore, the mine operator should become familiar with the design, operation, and maintenance of the various rock drills and the requirements of a tool to do his work more efficiently. He should be willing to spend considerable time, money, and thought on this matter and should be free with his suggestions to the manufacturer, untainted by any motive other than the desire to obtain a superior tool. He is in a position that, because of his intimate contact with the work done by the drills, can bring material assistance toward the advance of the art; and he should be slow in concluding that the ultimate of excellence has been reached in design.

The manufacturer is surrounded by many commercial conditions which inhibit his desire to develop new and more efficient designs if he has a reasonably satisfactory market for his products. He has a considerable investment in the jigs, fixtures and stock of spare parts for the tools he is selling, and these will be wiped out by obsolescence if either he or his competitors market a superior design, and his financial loss may be great. His tendency is unknowingly to magnify the virtues of his products. Competition and the alertness of discriminating customers are therefore chiefly responsible for advances in the art.

### Rock-Drill Manufacturers Challenged

With the hope that a free discussion may be provoked and a healthy outgrowth may result, operators may well challenge the manufacturers as to whether they have researched with sufficient pains into the fundamentals of mechanics upon which their rock-drill designs should properly be based. If so, the mining fraternity at large is not conversant with that fact, but has gained the impression that the development of drills has been largely by the "cut-and-try" method, combined with the application of ingenuity in the rearrangement of mechanisms. However, the tendency of keeping a watchful eye upon the mechanisms of a competitor, whose designs must therefore consciously or unconsciously tend to influence a new creation, is frequently present, and the resulting mechanism accordingly fails to be a distinct novelty in principle. As vigorous a refutation was made fifteen years ago as will now be made to this indictment, and yet at that time, some of the ablest and most experienced men in the manufacture of rock drills could not too strongly deride the possibility of the hammer-drill type of tool ever replacing in general work the old reciprocating type of rock drill. Nevertheless, it has done so, and with unthought-of benefit to mankind.

To be specific in setting forth inquiries, do the rock drill designers know:

1. What force and type of blows are best suited for drilling certain well-defined rocks and ores? This might involve knowledge of the modulus of elasticity and elastic limits of these rocks as well as their molecular inertia (or resistance to sudden deformation); also, the nature of the propagation of stresses through them and the limiting size of chips which could be cut by bits of a certain angularity without wasting energy in the needless crushing of material.
2. Do they know the amount of rotation of the cutting edges which should take place between successive blows, and have they provided for this?
3. Should the bit be against the rock when it receives energy from the drill, and, if so, what influence have various pressures against the rock upon the effectiveness of the drilling operation?
4. Have steps been taken to insure that the bit is away from the rock while it is being rotated?
5. Are the maximum number of blows per minute, effective upon a certain rock, limited by the resiliency of it, and what are they?
6. Can they define the energy which can be expended usefully upon the rock in terms of foot-pounds per inch of cutting edge; of course, different for various materials?
7. Have they studied the transmission of the vibratory compressional waves through the drill steel and the frequency at which these waves should be produced in order that the resultant initial and reflected waves should perform the greatest amount of useful work and so minimize the wasteful destructive energy evidenced by the heating and breakage of the drill steels?
8. Do they know the influence of the drill tappet on this sonic transmission of energy?
9. How can the amount of compression in the front end of the drill cylinder effect not only the nature of the piston blow but also the lingering of the piston against the drill steel so as to influence the nature of the reflected vibratory waves within it?
10. Can the nature of the vibratory waves be altered by a device on the drill steel or integral with the chuck bushing which will produce results analogous to a condensor or a choke coil as applied to the transmission of electrical energy?
11. Is it advisable to strike the drill steel with an accelerated blow or a decelerated one, and is it known as to which type of blow is present in various drills?
12. Have the instantaneous pressures in front and behind the piston been accurately measured, and how?
13. Are the instantaneous velocities of the piston known at various points in its stroke?
14. Have the sizes and lay-outs of the inlet and exhaust ports been determined by such studies of pressures?
15. Have similar studies been made of the action of valve mechanisms?
16. Has proper consideration been given in regard to the synchronization of the rebound of the air feed with the blows of the piston?
17. Has there been any fundamental research of the possibility of developing a method for drilling which would prove a radical departure from present practices? For instance, is it not practicable to combine some of the features of the Brandt hydraulic rotary drill with those of the diamond drill and the hammer drill and reduce the amount of chipping of rock by taking out a core at a higher speed than can be obtained by a diamond drill, because of the rapid hammer blows impressed upon the steel tube?

The art of drill designing invites scientific research, and it is decidedly advisable that such be initiated as soon as possible if this country is to remain in a position of supremacy in the rock-drill manufacturing and the mining industries. The task is not a small one, and so it should be planned as a joint co-operative effort of the manufacturers and the mines. It is fitting to place the sponsorship for such an investigation with a technical and disinterested body such as the U. S. Bureau of Mines. As the outcome of such research would be of general and national importance, its financing should be by the Government. It is hoped that sufficient interest will be awakened in the subject to bring sufficient pressure to bear upon the U. S. Bureau of Mines

and Congress to insure the undertaking of such proposed research.

The advent of successful motor-rotated block-holding, sinking, and stoping drills may be looked forward to as a development of the near future which will greatly increase drilling efficiency. An advance has been made in the production of such a type of drifting drills, and in one mine the use of this type resulted in so great an increase in drilling speed as to permit two men with one machine to accomplish more drifting than was formerly possible with three men and two machines. This achievement refuted the thoughtless contention sometimes advanced by certain representatives of rock-drill manufacturers—that the machines had reached such a perfection that it was futile and unreasonable to expect more from them, and that the mine operator should devote his attention to obtaining a higher productivity from labor rather than ask the manufacturer for higher drilling speeds. It is true that the drills are actually running a small proportion of any shift and that an effort should be made to increase their running time, but such a condition does not lessen the desirability of obtaining tools of superlative drilling capacity. The manufacturer who puts into practice his contention to the contrary will find business drifting toward competitors with more liberal views.

The contention is often advanced that drill design has so far exceeded the quality of the drill steel that it is futile to expect greater capacity from the drills until the steel has been improved. Although much may be hoped for in the improvement in quality of drill steel, this fact should not supply an excuse for lack of interest on the part of the drill designer, for it is probable that with sufficient study he will find is possible to apply energy to the cutting of rock so efficiently as to perform more useful work and reduce the stresses in the drill steels and drills below their values at present, and to permit higher drilling speeds with no heavier tools than those now employed. The mining industry may hope for the future to bring forth motor-rotated stoping, sinking, and drifting drills of double the drilling speed possessed by those at present available, and with no greater weight or destructive effect on the drill steels.

The motor type of rotation is cited as the coming advance in accepted design, as it avoids the inherent disadvantage in the rifled type of rotation of the interdependence of the rotation and the hammer blows upon the steel. The difficulties of mechanical rotation applied to air-feed drills do not seem insurmountable, although the unfortunate experiences of some operators and manufacturers with such drills, as so far developed, may serve to delay their production and general adoption.

Another inhibitory influence is the tendency for some workers, and especially organized labor, to revolt against an increased productivity, regardless of the fact that more work could be performed with no more or with less physical effort. However, it is hoped that this tendency will soon be dissipated, as there is a growing realization that the extension of the use of efficient and economical mechanical devices does not adversely affect the interests of the worker but makes a greater income possible for him through his increase in productivity.

The problem of the improvement of drill steel is now in hand through the activities of a committee representative of the steel manufacturers, the drill manufacturers, the mine operators, and the oil interests—all under the auspices of the metallurgists of the U. S. Bureau of Mines and the U. S. Bureau of Standards. A general research board will be organized from representatives of the various engineering societies and commercial organizations whose interests are involved, so that this work may be concluded in the most thorough manner. It therefore behooves the drill designer to make haste in perfecting his knowledge of his tools so that he may co-operate in the advance of the art of drilling.

# The Trend in Milling Practice

## Improved Methods and Increased Efficiency Will Rule — Proper Utilization of High-Priced Stores—Intelligent Stepping-up of Initial Operations—Standardization Of Parts and Methods — Comparison of Recoveries — Comprehensive Reports

BY GUY R. RUGGLES
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Inspiration, Ariz.

DURING THE SUSPENSION of mining operations which occupied either all or a greater part of the year 1921 and in some instances part of the year 1920 as well, every mill superintendent has had a chance to meditate on his failings in the past and to make many resolutions as to better methods of conducting his business in the future. Though not attempting to prophesy on the events of the year 1922, it would seem that the following conditions should govern:

The mill superintendent of a large concentrator will undoubtedly have a skeleton of his former organization when operations are resumed. If he is in charge of a small concentrator, his organization will probably have been disbanded. In either event he will find that skilled concentrator labor will not be immediately available. Many of his former employees will have been forced by necessity to seek their livelihood in other industries. Little by little, however, new forces will be gathered together. Recoveries and costs will be adversely affected somewhat in the interim, but as much of the unrest caused by the war and its after effects will have passed away, it will not be long before operations resume their former smoothness, and results will return to the best performances of former years. Lower wages will prevail, but this will be offset by a decreased cost of living.

### USE OF MATERIALS IN STOCK

It will be found that the warehouse shelves are crowded with the materials purchased under the stress and strain of the war and the resulting confusion following it. Large stocks will have accumulated. Much or all of this material will be higher in price

than material which it will be possible to purchase currently. Many contracts made in 1920 will still be binding. In any event, this material should be used before new is purchased. Fortunate indeed will be the mill superintendent who finds his stocks low at this time. New purchases will carry much lower prices than those which have prevailed in the past few years, but, owing to excessive freight rates, prices will still be high when compared with the year 1913 and earlier.

Power conditions for 1922 will depend more or less on the source of the power. If it is derived from fuel oil, little relief in cost can be anticipated. Freight rates on oil may decrease, but present indications are that the price of oil at the wells will advance. Coal-fired plants should furnish cheaper power than formerly, owing to decreased freight rates and higher labor efficiency. Hydro-electric power from present installations should approach pre-war prices.

Although handicapped by reorganization, the mill superintendent will find this handicap a means toward economy. Operations will probably be resumed slowly and will be on a rising scale rather than on a fluctuating or decreasing scale, as in the years 1919 and 1920. Sub-foremen who were a necessity in a large organization and whose services were retained even during a partial curtailment will not be needed until operations have reached a point more extensive than they were when the shutdown of 1921 occurred. New combinations of work, which are always awkward and difficult to initiate while operating, will be made without difficulty. If possible, scattered offices, laboratories and sampling rooms should be gathered together, thus promoting efficient interdepartmental work and supervision.

In 1922, the time will surely be opportune for the installation of many automatic devices for the economy of labor, and, further than this, for the development of new ones. There are many different signal systems for summoning men. Bells, horns, lights, or whistles are all satisfactory if applied under the right conditions. For all-around satisfaction, however, the telephone is probably the best.

Pumping machinery will run with little attention, requiring oiling and inspection only at long intervals. Centrifugal pumps, used for raising solutions or water, are especially adaptable to automatic control. This can be accomplished electrically, by float valves, by admission of air to the suction or by a combination of these means. In pumping water it will often be found more economical to abandon, or to use as little as possible, many outlying, isolated stations and do all the pumping from a central station, assuming that the central station is better designed and equipped with more efficient machinery. Such a procedure will often be economical even under the condition of a higher lift from the central station.

### Intelligent Handling of Repair Work

The rapid handling of repair work is something that is always to be desired. Most large mills are equipped with cranes, either motor driven or hand operated, at least over the floors where the heaviest work is done. If the crane has but one hook for heavy loads, it will often be advisable to add a smaller hook, for fast work. It may be possible to install a crane here and there in a small mill. Of course these would not be power driven, or have a power hoist, but they would serve to move quickly the various parts of a machine to one side and to bring them back to place when the desired changes had been made. If the mill superintendent is not able to install a bridge crane, a jib crane may suffice or at least a crawl with a trolley. This is especially of value where it is necessary to reline ball mills in place.

Where mill supplies are handled in large quantity it will be advantageous to move them mechanically, or, if this is not possible, at a minimum of labor. In the absence of a mechanical or magnetic scheme for handling balls, it will be found that they can be transported long distances by rolling, in the concave side of a channel iron. This can be done with a small amount of slope, provided, of course, that the balls are not too heavily burdened with knobs and accretions. Flotation oils, wherever it is possible, should be carried from the supply tanks to the point of use by pipes. The transportation of oil in cans or barrels always results in waste.

To the mill operator, central control is probably of the greatest assistance in his work. It will be a help to him if the water valves which he constantly uses are conveniently placed, if he does not have to go too great a distance to regulate an air valve, and if a clutch or starting compensator which he is likely to use frequently is near to the scene of operations. These minor operations can often be accomplished by small changes in existing conditions. Such changes will help to keep the operator on the job where he can give the machinery under his care the best of attention.

### Conservation of Effort in Supervision

Close supervision of operations at all times is important. The mill foreman is of limited endurance, and two complete rounds of the mill is often as many as it is possible for him to make in an eight-hour shift. Why could not escalators, which are so efficient in large department stores, be installed for the benefit of the mill foremen and others whose duties demand of them much stair climbing? If the shift foreman could thereby double his number of rounds, such a device would surely be worth installation. To a small mill such a scheme would not be practical, but it will often be possible to put in a new flight of stairs or rearrange the old ones in such a way that going from one part of the mill to another will be much easier.

Before ordering supplies extensively in the year 1922 every mill superintendent should look over the discarded material. All plants have scrap heaps, and during the years 1916, 1917, and 1918 these scrap heaps received large additions. This was probably from two causes; first, that a possible delay was assumed not to be worth the cost of the material involved; second, a shortage of labor which made it unwise to take chances on the use of old material.

In connection with the use of old material a second-hand warehouse will be of great value to many concentrators. Here should be collected the various odds and ends that are to be found scattered about every metallurgical plant. Gather up all the bolts, nuts, pipe fittings, and countless other small parts, which unless picked up are eventually lost. Possibly on some of these it will be necessary to do some work. Pile this material neatly and systematically so that it can be delivered at short notice. Assemble all the old pipe, and if encumbered with fittings, remove them, so that the pipe can be delivered as pipe. Structural shapes of all kinds

should be salvaged and put in condition for future use. Discarded transmission machinery should be disassembled. Then, when a pulley of a certain size is desired it will not be necessary to spend two or three hours to find it and as many more to remove it from a rusty shaft.

In this sorting, much cast iron, brass, and copper will be reclaimed which can be recast into new shapes. In addition to general supplies many special parts will be uncovered which in many instances it will pay to reuse. In a large plant the ratio of the cost of a ball-mill lining to the labor involved in a lining change is large. A fair estimate would be about sixteen to one. Hence, if a set of liners can be salvaged and operated for a sixteenth of the ordinary length of life, the work done has been paid for. Very often pinions and gears are discarded with only one side of the teeth worn. If these are placed in the second-hand warehouse, and used whenever a call for a new one is made, the results will often be surprising.

### Systematizing and Classifying Scrap Material

After looking over the scrap heap, the mill superintendent should see if the storekeeper can be assisted in using some of the slow-moving and surplus stocks. Perhaps some of the mill superintendent's predecessors have had pet ideas with reference to hose, belting, flotation oils, balls, and the like. All of this material cannot be used at once, but little by little it can be turned to good account. Possibly the material in question may not meet the approval of the present superintendent, but if it is in the warehouse it has been purchased by the company, and much thought should be expended before new material is ordered when there is something on hand that will give satisfaction.

In a large concentrator, supplies are a bigger item than labor. The ratio will probably be about two for supplies to one for labor. Hence, though labor should not be wasted, the big economies will be made in material. During 1922 (and as far as that goes thereafter), it will behoove the mill superintendent to economize on supplies. The year 1922 should be a period of economical operation, and no item will be too small to merit consideration.

In the attempt to increase the life of material, an intelligent study of conditions should be made, followed by tests that have been carefully planned. Records should be kept of such tests. If the problem is the search for a grinding medium, be sure that ore tonnages are right and that the weights made from time to time are correct. Close co-operation with the manufacturers will probably lead to the development of steels fully as cheap as those used in the past and which will give far better results in pounds per ton. Studies of wear on the worn liners from ball and tube mills should be made, and from these studies new liners developed. Only in this way can metal be removed, or added to the liners, intelligently.

### Proper Use of Flotation Reagents

If the problem is that of flotation oils or reagents, perhaps there are other combinations of oils that will do better than those in use. On the other hand, perhaps different percentages of the same oils will do better, not necessarily as to recovery but in devising a more economical mixture. In this work, one should make haste slowly, changing only one variable at a time and giving the new mixture a reasonable test in which to make its effect known. If quantities of oil are being investigated, conclusions should not be based on small daily measurements, but rather on the measurements of the main supply tanks over long periods. In some mills, belting will be the big problem. The majority of concentrators are probably over-belted. The belting should be studied as to widths and plies as well as for quality. Careful records should certainly be kept here. In a large concentrator it will pay to have one man devote either a part or all of his time to this study of the life of materials.

The standardization of material and machines is one of the most efficient aids to economical operation. This quickly results in fewer parts to handle, smaller stocks, and fewer kinds of machines with which operators must make themselves familiar. In general, the first thing to do is to get rid of as many "lefts and rights" as possible. Many times a bolt hole added, or some minor feature removed, will accomplish this. If there are a number of grinding mills on the job, see if the same size of bolt cannot be used, then make the scoops the same, then perhaps the liners can be duplicated.

Elevators, with their multiplicity of parts, are easy of standardization as to parts. If there are a number of different pumps, clutches, tables, filters, or flotation machines in the mill, ascertain which is the best, and gradually work toward one machine, eliminating the others. The conveyor, drive, and elevator belting should be studied and a small number of sizes determined as being necessary to carry. Much could be written on the subject of standardization, not only of material, but, if a company is operating more than one concentrator, of methods.

### Economy in Power

Economy of power in 1922 will have to be accomplished by economy in its use. First of all, keep every machine at capacity. The larger proportion of power in a concentrator is used in moving the machines. Under either heavy or light tonnage conditions, the power load approaches a constant. Therefore the largest tonnage on each unit in operation, consistent with the best recovery, will result in the lowest cost of power per ton and also per pound of metal recovered. Roller and ball bearings will probably become more of a factor in power transmission, and their use at places where much power is consumed is well worth investigating.

Attention should be given to lubrication. Avoid the use of belt dressing where possible. It not only damages the belts but it increases the power consumed. Wattmeters are invaluable. Every small concentrator using electrical power should have its total incoming power metered. For a large concentrator, more meters would be practical.

Assaying and sampling are of extreme importance. It is by these that the extraction of the desired metals is determined. One assaying method should be checked against another, as well as checking the technique and application of each method by check samples. The sampling should be done carefully and intelligently.

### Keeping of Records Important

The keeping of records has been previously mentioned. This should be given the best of attention. The foremen should be encouraged to keep accurate data. Give them note books in which to jot down happenings, rec-

ords of breakages, and their own personal observations. The official records, however, should be kept in the superintendent's office. Cards should be maintained on all the most costly items, such as conveyor and elevator belts, roll shells, and ball- and rod-mill parts, and this can be continued down to the smaller items, always remembering, however, that it is better to have a few records that are correct and used than many that are doubtful and neglected.

Whenever tests are under way, the foremen should be given an intelligent explanation of what it is hoped to accomplish. They will be able to offer many helpful suggestions to further the object of the test. Every mill superintendent should keep before him in his office plots of the principal daily results. In this way he can watch the fluctuations of the different factors far better than by scanning the daily reports. These curves should always be kept up to date.

Undoubtedly there will be many changes during 1922 for the installation of new machines. Improvements are constantly being made in grinding machines. The rod or roller mill is attracting attention. Interesting comparisons of air lifts with elevators are beginning to appear. Sand pumps are being improved in design. Screening devices have been making rapid strides. Coarse crushing machinery is being developed. From all this progress in the art, the mill superintendent will undoubtedly be able to pick some devices to lower his costs.

### Recoveries Should Be Compared

In the effort to reduce costs, the factor of recovery should not be overlooked. By this time the flotation process has been introduced into nearly every concentrator, but it is possible that it is not always applied correctly. Intelligent experimentation with the oils at hand or with new oils may reveal new possibilities. Are the water conditions for flotation correct? Will the use of additional reagents help or hinder the process?

The calculated recovery as determined from the assays of the feed, concentrates and tailings should be constantly compared with the actual recovery as determined from the assays and weights of feed and the concentrates. Such a comparison will often reveal discrepancies that seem unbelievable and which should be minutely investigated.

In the treatment of very low-grade material, much information can be derived from microscopic examination. A small amount of money expended in this manner may give a clue as to the condition of the mineral present and what process would be best suited for its treatment. In many operations such an examination might prevent the expenditure of larger sums where the chances of success are remote.

All portions of the plant engaged in recovering mineral should be closely analyzed to determine if each department is operating at a profit. If this investigation brings to light a money loser, see if the offending member cannot be brought into line.

Safety and cleanliness go hand in hand. The men should be educated in safety-first work and in hygiene. By the establishment of safety committees, the encouragement of safety suggestions, and the awarding of safety prizes, the former will be attained. By personal appeal to the men, it will be possible to attain the latter.

Last but not least, there should be the closest cooperation among all departments. The mine superintendent may not understand the effect that the presence of grease and sewage in the ore exerts on the flotation process. Then there is the effect of a varying head assay and the effect of ore from different stopes, levels or drifts on the recovery or grade of concentrates. The mine superintendent will have his problems too, but if the superintendents get together each will have a better understanding of the others' work and the general operations will be benefited.

# Copper-Smelting Industry

## Reduced Costs Simultaneous With Curtailed Production Are Impossible—Increasing Demand for Copper Imperative—Improvements in Receiving, Crushing, Roasters, Sintering, Reverberatories, Blast Furnaces, and Converters

By A. G. McGregor
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IN GENERAL, in the mining and smelting industry, low costs go with high production. It is impossible for the industry as a whole to meet the present situation by reduced costs and reduced production at the same time. The solution of the problem lies in increasing the demand for the metal.

The war had its effects upon the smelting industry, some of which will be permanent. It is well known that practically no other established pre-war industry has suffered as keenly in the transition from high-record production as has the copper mining and smelting industry. Then the profit was certain, and the problem was how to get the greatest possible production. Now the problem is not as simple, and apparently it will not be for some time.

The present situation has brought home forcibly the defects in the organization of the industry. It is now fully realized that copper has never been exploited to the extent that the best interests of its possible consumers deserved. Also, it is realized that in no other important industry has there been such a wide gap between the producer and the ultimate consumer.

At present the copper producers are in the same situation that the iron and steel producers would have been in if they had disregarded all responsibility for their products beyond the stage of producing pig iron and steel billets. Some of the copper producers are preparing to market finished products, just as the steel people do. Only by this policy, which is entitled to the full co-operation of all copper producers, can the industry be stabilized and fully exploited to the greatest benefit of all.

The war has undoubtedly caused a permanent change in the fuel-oil situation, with which the smelting industry in the Southwest especially is concerned. The smelting interests are confronted now with a permanently higher relative price for fuel oil than before the war, unless there is a marked change in the available supply.

This situation may make commercially impracticable the use of fuel oil in reverberatory smelting, which has been general in the Southwest for many years.

Though most of the copper-smelting plants were shut down nearly two-thirds of 1921, some plans for improvements have been made, and certain smelting-plant construction work has been carried on, notably the work on the Cerro de Pasco Copper Corporation's new plant in Peru.

Several copper-leaching plants are under consideration. So far, the use of furnace smelting methods has not been impeded by the introduction of leaching processes, but, instead, each has its own field of operation. How long this will hold true no one knows. It is safe to say, however, that important improvements will be made in both methods from time to time, for many years.

### RECEIVING—SAMPLING—CRUSHING—BEDDING

In the receiving of coarse ores no particular development has taken place in recent years. A special machine has been constructed at the Garfield Smelting Works for excavating flotation concentrates from the flat-bottom gondola cars. This machine also automatically samples the concentrates in the unloading operation. A detailed description of this installation appeared in the Jan. 1, 1921, issue of *Mining and Scientific Press.*

The auger sampling, used for both flotation and gravity concentrates received at the International Smelting Co.'s plant at Miami, has been developed to a highly satisfactory stage for all concerned. The system of unloading and sampling used there operates at a cost of about 2½c. per ton of concentrates received. This system is being installed or planned for at several other plants.

For ore mined underground, gyratory crushers continue to be more popular than the Blake type as primary crushers. As primary crushers for ore from steam-shovel operations, large Blake type crushers seem to have the preference. For intermediate crushing and crushing to ½ in., opinion seems to be divided between Symons crushers and rolls. The Symons machine has advantages in floor space and head room occupied, which are sometimes a determining factor.

At the new Cerro de Pasco plant, horizontal Symons crushers will be used for the intermediate crushing, and rolls for the finer crushing. This practice will also be used in the crushing plant now being planned for at the United Verde Copper Co.'s plant at Clarkdale, Ariz., except that the vertical Symons is to be employed instead of the horizontal for the intermediate crushing. For screening, the flat inclined vibrating screens are taking the place of revolving trommels.

### ROASTER FURNACES

There is a tendency to increase the number of hearths on roaster furnaces, which permits a lower limit of sulphur content of the charge before extraneous fuel is required. In the larger roaster furnaces, common red brick for hearths and linings has given way to the use of firebrick. On the hearths having drop holes in their outer circumference, there is a tendency to make these holes as large as possible, consistent with the strength of the hearth required at the drop holes. The center drop holes have the same effective area as the total area of the outer drop holes. Some of the special high-temperature bonding cements are being used with good effect in roaster furnace brick work. By the use of these cements, the furnace lining and hearths are practically converted into a firebrick monolith.

The heat in the calcine is being conserved by insulating the containing hoppers, and the hoppers and the transfer car bodies are being arranged to offer less cooling surface per unit of cubical contents. The practice of conserving heat in roaster furnaces by using a special insulating brick next to the outer shell is continuing.

Cottrell electrostatic treaters are gaining in popularity as a means for recovering the fine dust in roaster furnace gases. The Cerro de Pasco's new roaster plant is being equipped with tube-type treaters. Each roaster furnace has its individual treater overhead. The treaters are connected by a header, however, so that any treater may be cut out for cleaning or for repairs. The United Verde Copper Co.'s plant is being equipped with Cottrell treaters for all the furnace gases. In this installation three types of treaters will be used, the tube type, the Tooele type, and a modification of the Hayden type.

Progress is being made in reducing the dust losses incident to the transfer of calcine from the roaster furnaces and the flue dust to the reverberatory furnaces. This is being brought about by more efficient connections between car and the calcine or dust hopper from which the car receives its charge, and by more efficient means of venting the car.

### SINTERING FURNACES

The Cerro de Pasco Copper Corporation expects to treat in its new plant a considerable tonnage of ore which will carry 2 per cent copper, 12 per cent zinc and 25 oz. of silver per ton. The ore will be smelted with other ores in the copper blast furnaces. The fines in this zinc ore will be sintered in Dwight-Lloyd sintering machines before being smelted in the blast furnaces. Ten sintering machines are being installed.

The arrangement of the sintering plant is much the same as found in lead plants. The fuel used will be powdered coal, which will be distributed to the various furnaces by the Holbeck system, furnished by the Bonnot company.

An effort has been made in the design of the building to get better ventilation and abate the fume nuisance usually incidental to the operation of sintering plants. The gases, after leaving the furnaces, pass through uptakes into cyclone dust collectors and then into downtakes to the fans. By this arrangement, dust will be removed and the gases will be cooled before entering the fans. Cooling the gases by increasing the length of pipe between a machine and its fan was found to be advantageous in overcoming trouble with the fan due to the condensation of sulphur on the runner, at one of the company's other plants operating on this ore.

### REVERBERATORY FURNACES

*Size.*—In reverberatory furnaces, where large tonnages are smelted, the practice is to use furnaces 24 ft. wide, or wider, and 90 ft. long at least. From experiments which he conducted at the Copper Queen smelter in Douglas, Col. H. H. Stout advocates materially shortening reverberatory furnaces. The furnace of greatest width is at El Paso, the inside dimensions of the furnace there being 28 ft. wide by 129 ft. 6 in. long.

*Skimming.*—The practice of allowing the slag to run off continuously through a seal at the skimming door, instead of skimming intermittently as in former practice, seems to be quite thoroughly established in many plants. This system of skimming has effected a material reduction in slag losses at a number of plants. In

certain properties using powdered coal having a particularly high infusible ash content, the exclusive practice of continuous skimming does not seem feasible. Also, in certain plants the slag track arrangement is such that continuous skimming is impracticable.

*Waste-Heat Boiler Settings.*—The arrangement of waste-heat boilers and the passages for the heated gases between furnaces and boilers, commonly used in the Southwest for oil-fired furnaces, has not been found well adapted to the use of powdered coal, especially when the coal ash is fusible. The header flue and the somewhat long and complicated connections tend to become clogged, requiring extra labor to keep them cleaned. Also, a lower heat recovery in the waste-heat boilers results, on account of the cold air admitted through the openings through which the work of cleaning out must be performed.

The United Verde Extension Mining Co.'s reverberatory furnaces were constructed to use oil fuel. Later it was decided that powdered coal would be the fuel used. A furnace with its waste-heat boilers, flues, and other appurtenances, as originally planned, was operated six months with powdered coal, and much trouble resulted from the clogging of the flues and connections between the furnace and boilers by fused ash and dust. Later, the boilers were raised and moved close to the furnaces so that the connection between furnace and boilers was short and direct. This overcame the former trouble completely. The slope on the bottoms of the connections is such that any sticky material dropping down between the furnace and boilers drains back into the furnace. The sticky particles passing into the boilers are cooled by the tubes and drop down as a dust into the hoppers below, from which the material is easily removed through doors provided for that purpose.

The furnace and boiler records show that with the original boiler setting the evaporation in the waste-heat boilers was 3.8 lb. of steam per pound of total coal burned in the furnace and the dryer at the pulverizing plant, whereas with the new setting the evaporation is 4.56 lb. of steam per pound of total coal burned, an increase of 20 per cent. Stirling type boilers continue as the favorite waste-heat boiler in copper-smelting plants.

*Draft Control.*—At Anaconda, C. R. Wraith and L. E. Jones have devised a sensitive regulator for operating the dampers situated at the rear of the waste-heat boilers. By the use of their system, a minimum draft is maintained in the furnace, which furnishes just the right amount of air for the best results in the combustion of the powdered coal fed to the furnace. The advantage of only a slight negative pressure in the furnace, together with the proper combustion mixture, is apparent, and this system of draft control has effected an important saving in fuel required for reverberatory smelting at the Anaconda plant.

*Charging.*—In connection with the charging from overhead hoppers at Anaconda, cast-iron water-cooled collars, set in the arch brickwork, are being used for the charge holes, with good success. A new method of charging reverberatory furnaces is being tried out on one of the furnaces of the Arizona Copper Co.'s plant at Clifton. This is described by J. O. Ambler, the plant superintendent, in *Engineering and Mining Journal* of Jan. 29, 1921. The charge is fed slowly but continuously through holes in the side wall, near its top, by means of screw feeders. This results in the accumulation of charge along the side walls, which slopes down and protects the wall. The new charge trickles down slowly over the slope and partly melts before it reaches the molten bath at the toe of the slope.

At the International Smelting Co.'s plant at Miami, work is under way to try out another side-charging method on a furnace there. On this furnace, the charge will be positively forced through charge holes in the side wall, down near the slag line, by means of a plunger. By this method, the charge will be bulged out in front of and above the charge holes, affording a protection to the side wall. The charging will be intermittent. Each charge will be forced underneath and back of the previous charge. In this way, each charge will gradually advance, step by step, toward the interior of the furnace. The oldest and hottest unmelted charge material in the furnace will be the fusing surface, directly exposed to the interior heat of the furnace, and the newest material in the furnace will be the coldest and will be directly against the side walls.

The present methods of charging appear crude indeed when it is realized that a comparatively cool, dusty charge is dropped through the furnace arch into the rapidly moving, highly heated gases of the interior. A cloud of dust rises in the furnace, the brickwork of the arch is fluxed away by this dust, and valuable dust is swept along through the furnace into the flues and boilers, where it is reclaimed with difficulty. Also, valuable dust is carried out the chimney, and the furnace is alternately cooled and heated, resulting in inefficiency. There is certainly room for improvement in charging reverberatory furnaces.

## BLAST FURNACES

*Charging.*—The blast furnaces at the new Cerro de Pasco plant will be charged in the same manner as the furnaces at the Calumet & Arizona and United Verde Extension plants are charged.

*Powdered Coal Substitute for Coke.*—Encouraging results have been obtained in the Cerro de Pasco old plant with powdered coal as a substitute for coke. If the results obtained on ten-day runs can be maintained continuously, an important saving in the cost of fuel will result. The main sources of delay and interruption in this application of powdered coal have been in the lack of a dependable mechanical method of delivering the fuel to the furnace. For the best results, it is desirable that the fuel be always available at the many points of application, in whatever quantity required. At present a modification of the Holbeck air powdered-coal circulating system, which has been successful in plants having large numbers of comparatively small furnaces, is being installed and will be in operation soon.

*Jacket Cooling.*—A thermo-syphon cooling-water system for blast-furnace jackets has been worked out by Norman B. Roper, formerly with the Cerro de Pasco Copper Corporation, at one of that concern's older plants, and will be used on the blast furnaces in the new plant. The thermo-syphon cooling system will operate with a minimum of new make-up water, and in operation has been found thoroughly dependable, relieving the furnace men of worry about the possible failure of the jacket-cooling-water supply.

*Hot Blast.*—At the United Verde plant at Clarkdale, Ariz., the blast air for the blast furnaces has been heated to about 200 deg. F., for several years, by passing it through a system of pipes in the furnace tops before entering the furnace tuyères. Plans are now being made for an improved heating system in the furnace tops, whereby it is expected that it will become prac-

ticable to extract more heat from the furnace waste gases and materially to increase the temperature of the blast air entering the tuyères.

*Sulphuric Acid as a Byproduct.*—At Copperhill, Tenn., the smelting plant delivers about 90 per cent of all the sulphur contained in the ore to the acid plant in the form of $SO_2$ in blast-furnace and converter gases. The acid plants recover in acid about 92 per cent of the sulphur in the gases delivered to them.

### Reverberatory vs. Blast-Furnace Smelting

In the Southwest, the relative costs of fuel oil or powdered coal for reverberatory furnaces and of coke for blast furnaces are such that the reverberatory furnace has a decided advantage over the blast furnace. Under the conditions, and with the value of the waste-heat steam obtained in reverberatory-furnace operations, the advantage more than compensates for the extra cost of crushing and roasting required in reverberatory smelting.

### Converters

*Type.*—Though at present more matte is converted in the so-called Great Falls type, or upright converter, it is my opinion that the majority of smelting-plant superintendents favor the barrel type, or so-called Peirce-Smith, type of converter. The American Smelting & Refining Co., in several of its plants, is using the large 13-ft. by 30-ft. Peirce-Smith converter. This is a rather large size for many plants, and where only one or two are operating, the demand for converter air varies through wide limits, causing a fluctuating demand for steam. Also, with high-grade matte, the use of the large converters results in large quantities of copper being finished from time to time, which practically necessitates the use of a tilting storage furnace or a refining furnace between the converting and casting operations.

The steam for compressing converter air is generally furnished by reverberatory waste-heat boilers, and there is often an advantage in keeping the demand for steam as uniform as possible. To accomplish this in the new Cerro de Pasco plant, and to avoid the use of a tilting copper furnace, the expedient of using more units of smaller converters is being adopted. A 12-ft. by 20-ft. Peirce-Smith converter has been developed, five stands of which are being installed.

*Garr Gun.*—The Garr Gun is widely used for feeding the siliceous ores into the Peirce-Smith converters. The operation of feeding the siliceous ores into the converters is usually attended with considerable hand manipulation and attention by the operator. In the new Cerro de Pasco plant, roller type feeders are used for feeding the ore from the overhead bins down through pipes into small, narrow, tapering hoppers, which at their lower ends curve into the ends of the converters, so that the ore will almost discharge into the converter without the aid of the air jet of the Garr Gun. In the operation of feeding in the siliceous ore charge, the attendant merely opens the gate in the hopper on the converter, admits air to the Garr Gun, and through a remote control starts the small motor which drives the feeder. The amount of the charge is measured by the length of time the feeder is run.

*Converter Blowing Equipment.* — Turbo-compressors have been used to some extent for furnishing converter air, but where they are steam driven, and where the value of steam is important, they have not been able thus far successfully to compete with the reciprocating type of steam-driven blowing engines in copper-smelting plants. It seldom happens that fuel is found near copper ore deposits, and about the highest prices are often paid for fuel at the copper-smelting centers of the United States. This, together with the fact that in copper-converter plants the demand for air is quite variable, places the turbo-compressor at a disadvantage. At best the turbo uses more steam than a reciprocating engine at its rated capacity, and at partial loads the economy of the turbo falls off quite rapidly, whereas the economy of the reciprocating blowing engine remains nearly constant through a wide range in the amount of air delivered.

*Converter Slag.*—Converter slag is successfully granulated at the Tooele plant of the International Smelting Co. Where there is a shortage of base in the reverberatory charge, the full benefit of all the iron in the converter slag can be realized by mixing it in the granulated form with the charge. Only a part of the fluxing value of the converter slag is realized when it is poured into the furnace in its molten state. A converter-slag granulating equipment is being installed at the new Cerro de Pasco plant.

*Copper Casting.*—The practice of pouring blister copper from a tilting furnace into the casting machine has been common in recent years. However, the operation of the tilting furnace entails considerable expense, and where anodes are not required it will likely be displaced to some extent by improved casting machines permitting faster pouring from the copper ladle and giving bullion bars with fewer fins and need for chipping, all of which will contribute to reduced costs.

### Copper Producers Will Manufacture Their Own Copper Specialties

At present, interest in the process of producing copper, to most men connected with the mining and smelting industry, ends with the operations at the converter plant. Undoubtedly, in a few years, as intimated in a preceding paragraph, they will be concerned in the other processes through which it passes before reaching the consumer, and it is probable that a number of the larger copper producers will eventually manufacture their own finished copper specialties.

The reputation of copper has suffered in the past through the sale of defective metal. There is need for more exact processes in refining and for more uniformity in all the properties of the finished material. If it is not feasible to make a uniform finished product, the finished metal must be more uniformly graded and the various grades must be standardized. There is yet much to be learned of the possible alloys and their properties. For the best interests of the producers, close co-operation is required in working out these problems, to the end that the most suitable metal may be furnished for each of the various present uses and the added uses of the future.

The co-operation of the men of the smelting industry in its development and in its many problems of production has been proverbial. The logical continuation of this helpful policy will greatly hasten the solution of the industry's now apparent more vital problems, including the creation of a logical demand for their valuable product through a wider knowledge by the public of its true worth, and in providing facilities whereby those desiring it may be more efficiently served, both in respect to quality of metal and utility of manufactured article.

# Current Problems

## Licensing the Mining Engineer

### Burden of Proof of Desirability of the System Rests on License Proponents—Relation Between Mining Engineer and His Clients Not Analogous to That Governing the Individual in Public Service

BY H. G. MOULTON
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THE MOVEMENT to abridge the individual liberties of the engineer through registration or licensing is a part of the general restrictive tendency of recent years. The trend being present, and accelerated by conditions prevailing during the war, only the stimulus of some specific demand was required to bring about the movement to limit and confine the engineer's liberty of action and technical status. This demand came in the beginning from engineers who felt that their compensation was not proportionate to their worth, particularly when compared with the compensation of skilled or unskilled laborers during the war. In casting around for some remedial measure, the trade union idea was seized upon, and it was thought that through restriction in numbers the law of supply and demand would operate to increase the engineer's compensation. The idea found ready support in legislative bodies because of the fact that state expenses were increasing faster than state revenues and the fees to be charged for registration or licenses would form a welcome addition to income.

#### LICENSING IS SPREADING

An excellent survey of the extent to which the licensing movement has progressed may be found in an article by B. B. Gottsberger in the November, 1921, issue of *Mining and Metallurgy*. Mr. Gottsberger's article is so thorough and so interesting that it should be read by all mining engineers, and no attempt will be made to summarize it here. Nineteen states now have laws regulating the practicing of engineering, and as the mining engineer commonly practices his profession in many states besides the one in which his office may be situated, he is affected by, and must be conversant with, the licensing laws of his own state and also those of other states in which such laws are in effect. He is, therefore, vitally interested in the existing situation, and should be even more concerned in the outlook for an extension of the movement into other states. The mining profession as a whole has given little thought to the spread of restrictive measures, and before the movement is extended to other states or becomes nation-wide through the passage of a Federal law, it is necessary to determine our policy as a special class in the engineering profession and also to determine what, if anything, may be done about it.

In order that individual freedom, which is our most precious heritage and because of which our country has progressed so greatly, may be safeguarded and protected in every possible way, it is necessary to scrutinize every restrictive measure, principally from the standpoint of absolute necessity. The burden of proof should be on the proponents of every restrictive measure, and not on the opponents. Therefore, as mining engineers, in opposing licensing, are not on the defensive, both as mining engineers and as part of the citizenry of the country, we must be convinced that the value to the many is greater than the harm to the few before supporting such measures, or even before voluntarily consenting to their consideration.

The problems of other classes of the engineering profession may be somewhat different. It may well be that in theory surveyors or engineers who may be hired by the general public to determine land lines, boundaries of mineral claims or town lots, or even to plan or construct highways, bridges, or other engineering works for the use of the public, should be limited in their practice by state authority. With the mining profession, however, the conditions are entirely different, for the reason that mining engineers as a whole do not have the general public as clients, and the problem of the relation between the individual and the state, or the individual and the public as a whole, is not present, as with doctors, lawyers, dentists, or perhaps even certain classes of civil engineers. The latter professions also commonly serve people of comparatively small means and not in a position to judge for themselves as to professional qualifications. The mining engineer as a rule deals with a company, a financial institution, or an individual of means and standing, and the relation is one between competent individuals—in no way a proper matter for state concern or state control. In attempting to enter this field of determining the qualifications of an individual who will be employed by another individual competent to determine such qualifications, the state is therefore going outside of its proper function and the action is to be condemned on grounds of unnecessary interference with individual freedom.

#### MINING ENGINEER AND CLIENT COMPETENT INDIVIDUALS

It may be argued that the public as a purchaser of mining securities is directly concerned with the qualifications of the engineer. The answer to this is that the general public does not buy mining securities on the basis of engineers' reports; its opinions are formed rather on brokers' circulars, tips from friends,

newspaper articles, and similar publicity, to the extent that they are formed at all. Interests desirous of selling unsound mining securities to the public need in no way be handicapped by requirements for licensing which are intended to prevent unqualified engineers from reporting on mining projects. Even if such licensing requirements should bar from professional practice the dishonest or incompetent engineer (which is not necessarily a sound assumption), the public may be supplied with what are only the opinions of some superintendent, manager, business advisor, circular writer, or anybody else who can be made to speak with a glib tongue on mining matters.

Aside from the large group to which we refer in vague terms as the general public, there is a class of small investors, few in number, who buy securities of sound mining companies issued or sponsored by reputable banking houses, and such investors undoubtedly give weight to the standing of the engineers reporting on the properties. However, they necessarily give as much or even more consideration to the standing of the banking house and to the management of the companies involved. The investor's protection in such transactions is that the banker who sponsors the security issues and recommends its purchase to his clients, and is the one who must judge of the qualifications of the engineer. The engineering report, being only one phase of the whole business problem, the investor who trusts the banker will trust the banker's judgment as to the engineer. Can anyone seriously believe that the type of banking firm which would place the securities of an Inspiration, a Utah, a Miami, a Braden, or a Chile would need the protection of a state license in its relations with the engineers reporting on the properties? To the banker, the licensing laws would be only additional nuisances, in that at times it might be necessary to determine whether or not some aspects of the licensing laws would prevent the use of extracts from engineering reports in circulars sent to certain states. Activity is not so pronounced in the field of new mining finance, or unemployment so rare among engineers, that our representatives in the state legislatures can afford to place even slight unnecessary handicaps on the business of placing securities.

### Mining Engineer Receives Nothing for License Fees

Having established the point that the relation between the mining engineer and the client is normally one between competent individuals, and not one between an individual and the public, and therefore not a proper function for state control, it is unnecessary to argue as to the extent to which the state may find it possible to protect individuals by attempts to determine the qualifications of mining engineers. The state need not and should not do so; therefore there is no reason to argue as to the methods by which it might do so.

What will the mining engineer receive in return for the fees which he must pay to the state or states in which he may practice? Nothing. Mining engineers are chosen by their clients because of particular skill as executives, as consultants, or as technologists. More than in any other profession, the mining engineer must possess judgment, and this may or may not be acquired by education and experience. The investor seeking the services of a mining engineer, or the mining company seeking an executive, must judge the man's abilities by his record, and seek the advice of others familiar with his judgment. I am of the opinion that the investor will give just about as much weight to the framed license hanging in the engineer's office as he will give to his certificate of membership in the National Geographic Society.

The license or registration fee is therefore somewhat on the order of an occupation tax. It is on the order of an occupation tax, rather than an occupation tax, for the reason that it is, after all, only a tax on the use of the term engineer in connection with an occupation, and not a tax on the occupation.

To develop this thought further, consider on the one hand the general superintendent of a contracting firm engaged in the construction of a great public work. The superintendent directs labor employed in excavation, steel erection, concrete construction, and like activities. He is able to estimate costs, to handle men, to design and erect temporary structures, and even to lay out work and to establish points by the use of the chalk line, the level, the carpenter's square, the plumb line, and the steel tape. The difference between him and the engineer in charge of the work often is that the superintendent can do many things without engineering training or surveying instruments which the engineer does with such training and with the aid of certain special instruments. The further difference is that the superintendent usually has larger responsibilities and also gets much more pay. Is the engineer not already sufficiently penalized by lower remuneration without a further penalty in the form of title tax for the use of the term engineer?

### Defining Professional Engineering

The New York law defines a person who practices professional engineering as one who holds himself out as able to do or who does the work that an engineer does in planning, designing, and constructing, or in making investigations for proposed engineering projects. Note, therefore, that the definition revolves about the idea of doing or holding oneself out as able to do the work of an engineer. Many of the things that an engineer does are also done by the construction superintendent, the business man, the industrial executive, the financier and the credit man. They, however, do not assume the title of engineer, and therefore do not have to pay the title tax. Similarly a legislature might pass a law providing for an occupational tax on hardware stores, and if the definition of hardware store were similar to the foregoing definition of an engineer, only the title hardware store would govern. A department store might be engaged primarily in selling hardware, but if it avoided the term it would avoid the title tax.

### Variation in State Statutes

The Michigan law appears to rest entirely on the question of title, stating that any person who represents himself to be an engineer shall be registered. The New Jersey law also uses a definition dependent upon title in that it defines professional engineering as the practice of the professional engineer who investigates or directs the application of the resources of nature to the use and convenience of man and who represents himself to be such an engineer through the use of the term engineer or the use of some other title implying that he is such an engineer. The Pennsylvania definition is practically identical with the one used in the New Jersey act. The Oregon law states that the practice of the profession of engineering embraces the design

and supervision of the construction of public and private utilities specified in considerable detail, the design and supervision of mining operations and of municipal works, irrigation works, and similar projects. The execution of such works as a contractor, or their supervision by a foreman or superintendent for a contractor, is excluded, and as the superintendent of a large contracting operation is, after all, truly an engineer of the very highest grade, in that he directs labor, utilizes the resources of nature, and actually puts into effect the plans which the engineer initiates, the Oregon law, to this extent, discriminates against the use of the term engineer. The definition in the Florida law is very similar to that of the Oregon law, and makes the same discrimination as to a foreman or superintendent for a contractor.

### What May Be Done About Licensing the Engineer

The conclusions stated suggest an interesting possibility in connection with the question of what may be done about licensing. If the engineer is to be taxed for the use of the name, is it not possible that under certain conditions he may operate freely without a license simply by avoiding the use of the term engineer? Let him call himself an industrial executive or a business advisor, and while operating as such executive or advisor why cannot he do the same things in connection with mining or smelting as others may do in connection with construction or operating factories; for what is mining but excavation, and what, after all, are metallurgical plants but factories? Why should the men who run a factory which extracts copper from ore be called engineers and licensed, and the men who mix the copper with zinc to form brass and later make the brass into various shapes be called by other names and not licensed?

For different classes of mining engineers the problem is, of course, somewhat different, but for the consulting engineer retained by a client to report on a proposed mining investment, the answer to the question of what shall be done about licensing may lie in the thought that one need not make the examination as an engineer but as a business advisor.

### Test Case May Be Necessary to Determine Exact Status

As an illustration let it be assumed that an investor asks a consulting engineer with offices in New York to go to some other state and examine a mine offered for sale. The consulting engineer is not licensed in the other state, and its laws forbid his practising engineering therein without a license. Therefore, he should go, not in the guise of a consulting mining engineer, but as a business advisor retained by the inventor for the purpose of judging a purely business and financial matter; that is, the advisability of purchasing and operating a mine. If the same investor were considering the advisability of investing in, say, a cattle ranch in Colorado, he could hire some man with expert knowledge in the commercial side of cattle raising and send him to that state to examine and report on the proposition. The investigator would not be called a cattle engineer and licensed accordingly. It would seem a proper function of the American Engineering Council to finance a test case by retaining a lawyer to handle the case for the first consulting engineer who would frankly ignore the licensing requirements of some state in which he was making an examination on the grounds that he was functioning as a business advisor rather than as an engineer. If this test case were successful, a later trial might be made by some operating mining company on behalf of one of its executives, on the ground that the law made an unfair discrimination between factory managers in metallurgy as compared with factory managers in other lines, or as between men in charge of excavation operations called mining on the one hand and superintendents or managers of contracting companies excavating for railroad cuts or doing other construction work.

Banks send credit men to investigate businesses in which they have or are asked to have a financial stake. Various types of financial institutions from time to time send experts to examine and appraise the operations of companies in which they are interested. Individual investors often send trained business investigators or advisors either to represent their interests or to advise them in connection with all sorts of transactions in which the investor has interests at stake. Why, then, should we, or why need we, assume that the position of the trained business advisor who investigates or appraises a business involving the operations called mining or metallurgy be put in a different class under the law and penalized for using the title of consulting mining engineer?

### The Mining Engineer Becomes Business Advisor

If the foregoing logic will stand the test of the courts —and it should be relatively inexpensive to determine this if some consulting engineer will offer himself on the altar for a test case—the answer is clear enough as far as the consulting mining engineer is concerned. He need only leave his title of consulting engineer at home in the office, and then he may operate freely as a business advisor in all states regardless of license laws, provisions for reciprocity, or other regulations or requirements. For he is calling himself a business advisor, and doing the work of a business advisor, and is not bound by restrictions placed on the one who calls himself an engineer and necessarily does the work of an engineer.

### The Engineer in Court Proceedings

It would, of course, be necessary to give consideration to the possible effect of such action on the position of an engineer in court proceedings. If he is making an examination in connection with a matter which may involve litigation, and consequently faces the possibility of being placed on the stand as an expert witness, it would not be advisable for him to jeopardize his position by ignoring licensing requirements and abandoning his title of consulting engineer, as the voluntary abolition of the title might jeopardize his qualifications in the minds of the jury.

After all, it would be difficult for any individual engineer to take effective action in opposition to present or contemplated restrictions on his engineering activities. Each, however, can and should register dissatisfaction as strongly as possible through every available channel, in the hope that organized effort to render ineffective existing license laws so far as they affect the mining engineer and to prevent the passage of similar measures in other states and territories or in Congress may be developed later in the interests of the public in general and of the engineer, whether he be engaged in mining or other professional engineering, in particular.

# Mining Prosperity and the Railroad Problem

## Successful Operation and Development of Mines Essential to Roads' Well-being—Increase in Freight Rates Serious Contributory Cause of Inactivity —Railroad Transportation a Controlling Factor in Mining Operations

BY F. R. RAIFF
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ASSUMING that there can be no question that there is a close relation between the railroad problem and mining prosperity, let me illustrate by the recital of a recent occurrence: An important mining camp in a certain Western state faced serious difficulties from the reduction in metal prices, lower grades of ores, and increased mining costs, due to higher labor, fuel, supplies, and freight charges. Having reduced all these items, except freight rates, as far as possible, the mine owners approached the chief traffic officer of the railroad serving the community with a request for reduction in freight rates on their ores to the smelter, saying that with the reduction asked for they could continue operations. The railroad company, also facing increased expenses for labor, fuel, and materials, decided after full consideration that no reduction could be made. The mines closed down. The population of the community scattered to the four winds, and what had previously been a considerable city became a fair representation of the "Deserted Village."

### RAILROAD OPERATION AT COST PREFERABLE TO DESERTED CAMPS

The traffic officer of that railroad stated afterward that he had figured the loss to the carrier in freight charges on the material and supplies for the mines and for the community, such as clothing and groceries, also the coal, coke and fluxes for the smelter in the treatment of the ores, and on the outgoing bullion, and had determined that it would have been better to have hauled the ores for nothing than to have suffered the closing of the mines. He added: "Never again will we allow a mine to close if any steps within reason which we can take will prevent it."

The railroads have had, and are having, their troubles, but some of their traffic officers did not realize soon enough the difficulties facing the mining industry. At the signing of the Armistice the prices of copper and lead were practically fixed by the Government (in the case of copper actually so at 26c. per lb. maximum). Production in this country was on a scale never before approached, with the Government taking nearly all of the production; hence, the suspension of hostilities in November, 1918, found large accumulations of copper, lead, and zinc in process at high costs, and a sudden and almost complete cessation of buying. The amount in process was much larger than normal, owing to the delays incident to the war work. Furthermore, at the earnest solicitation of the Government, production of copper was not immediately curtailed, this to avoid unemployment and as an aid to the general economic situation. Prices then dropped to less than half those obtaining in November, 1918, and today the price of copper is approximately 50 per cent of the maximum fixed by the Government, with lead and zinc at about the same ratio, whereas the freight rates are approximately 165 per cent of those of June 24, 1918.

After the operation of the railroads was taken over by the Federal Government, all freight rates were subjected to a general advance by the Railroad Administration. In June, 1918, came the so-called "general advance" of 25 per cent, some commodities receiving greater or lesser increases. Rates on smelter products advanced from 55 to 115 per cent and on these excessively increased rates were superimposed the general freight rate advances of August, 1920, amounting, on shipments from the Western mining states, to 33⅓ per cent. In some instances the rates of August 26, 1920, were more than 250 per cent of the rates effective before the advance of June, 1918. Among other commodities singled out for excessive advances was lime rock, used by the smelters for fluxing, the advances in some instances approximating 200 per cent or more.

As a result of these excessive advances, the industry sought new and cheaper routes for its products, and the equivalent of many thousands of tons of bullion on which the Eastern railroads had received satisfactory earnings before the increases was lost to them, a large part of the product moving from Montana, Utah, and Nevada to the Pacific Coast and thence via the Panama Canal to the refineries and the markets of the East at reductions of several dollars per ton as compared with the all rail rates. The revenues of the railroads were depleted by hundreds of thousands of dollars at a time when they were hungry for business, which was lost to them not so much through any action of their own as by the short-sighted policy of the Railroad Administration.

### EFFECTING READJUSTMENTS DIFFICULT

After the railroads were relinquished from Federal control, their traffic officials immediately sought to correct the conditions thus brought about, but though the Government, by the issuance of a simple order, could advance the rates excessively and disrupt differentials that had existed for years, the process of undoing all this was not so simple a task. After several months of effort, the railroads are beginning to get their tariffs lined up so that there is some semblance of justice in the advances the mining industry will pay on its products as compared with those of other industries.

A review of the results of the readjustment process contains much of instructive interest. The rate on lead from Utah, Montana, and Idaho to Chicago is $15.30 per net ton, and has been since Aug. 26, 1920. At present, the water rate on lead from Spain to New York is approximately $4 per ton. (The rate from New York to Hamburg, Rotterdam, Havre, and British ports is $4 per ton.) The rate from New York to Chicago is $7.70 per net ton. The lead from Spain can move more cheaply into Chicago than that from our own intermountain country, and over 20,000 tons was imported during 1921. Also, a large tonnage was moved in 1920, much of it into Chicago territory and paying the import duty. Copper or lead from refineries on the Pacific Coast, including

Puget Sound on the north and South America, move to the Atlantic Seaboard via the Panama Canal at $6 per net ton, and then by rail or canal to Rome, Buffalo, and other cities, at freight costs less than from the intermountain territory, all rail, to the same destinations, or to Chicago.

During the recent period when rail transportation was undergoing so-called "standardization" at the almost total disregard of the effect on industry, there crept into the hastily organized central control many rules and regulations that were not competent for general application. Many of these rules are still being applied and are hampering the mining industry.

The standard industrial track contract is troublesome to the ore shippers, and when encountered is doing much to create distrust and a feeling that proper cooperation is not being accorded in an effort to develop new properties. For example, it is difficult to criticize the impatience of one mine operator for whom a carrier offered to construct a loading track. He was asked to deposit the cost of construction. The deposit was to be refunded according to the standard contract, at a rate of $2 for each carload shipped from the proposed track. The track cost was $1,270. The refund would have been accomplished when 635 carloads were shipped. The carrier's revenue from the 635 cars would have been $254,000, based on the published rates to the smelter to which the ore would have been consigned. That shipper cannot be made to see that the carrier really wanted to help him.

Though transportation service plays a vital part in the industrial life of the country as a whole, probably no industry is more dependent upon it than the mining industry. Generally the mines are far removed from manufacturing districts of the Eastern states, where practically all of the products of the mines are marketed, used, or exported. Most of the mining machinery, materials, and supplies originates in the manufacturing districts of the East and must be transported distances ranging from 1,500 to 2,500 miles to the mines, or substantially the same distance that smelter products are transported to refineries and consuming points in the East. There is no industry in the country that requires as much long-distance transportation as the mining industry, and for that reason transportation service and costs are controlling factors in the development and successful operation of mining projects.

### Adverse Conditions of Small Mines

The prospector and small miner are operating today under adverse circumstances. Their properties may have favorable surface conditions, but it remains to be seen whether the orebody is of sufficient size and quality to make a successful project. The small miners are obliged to team their ore to the nearest railroad for movement to the most available custom smelter. Possibly the first ore is of sufficient value to cover the actual cost of mining and transporting it, but there are many instances when the early returns do not meet the outlay. On the other hand, the initial operations of some properties yield a slight profit, due to higher ore values, and in such operations development follows natural lines. However, it is the former, or low-grade surface properties, that are more numerous, and, for that reason, more important. In all such prospective developments rail transportation is the controlling factor.

This is especially true of low-grade properties. Any fractional increase in freight rates on low-grade ore curtails production, and if the increase is substantial it will completely stop the production of such ores. For illustration, if a certain district is mining 2½ per cent ore, which requires from 45 to 50 tons (depending upon the metal recovery) to make one ton of bullion, and there is an increase of 25 per cent per ton in the rate on ore, with no corresponding increase in the price of the refined metal, controlling factors of profitable production are equivalent to an increase of $11.25 to $12.50 per ton in the cost of bullion, or over ½c. per lb., which might in turn wipe out all profit and result in an actual operating loss. As a rule, transportation and the development of mines are so closely related that the railroads could well afford, as a business proposition, in prospective cases, to co-operate to the extent of hauling the ore at cost, at least until the early and unprofitable development work is completed and the mine is established on a sound basis.

### Mining Operations Produce Back-Haul Freight

Following the early stages of development, and even after the property has reached the stage of large production, the element of transportation costs continues to exert a marked influence on mining operations. The importance of this fact is emphasized when one considers that each ton of base metal produced represents an inbound movement of tonnage far in excess of that weight. In other words, it often requires from three to eight tons of inbound materials and supplies, exclusive of ore and concentrates, to make one ton of smelter products.

As a striking illustration of the extent to which the production of base bullion involves heavy movement of collateral tonnage, one of the prominent copper companies uses eight pounds of materials and supplies inbound, exclusive of ore and concentrates, for each pound of copper produced, and even the companies with the lowest operating costs and most favorable grades of ore use as high as 3½ tons inbound, exclusive of ore and concentrates, for each ton of copper. The movement of this enormous tonnage and the cost of transporting it are vital factors, not only in the prosperity of the mining industry, but to the prosperity of the carriers as well.

Without reasonable and fair freight rates and adequate service the mining industry cannot hope to thrive. The bare cost of transportation alone on the materials inbound and copper bullion outbound from Western smelters to refineries in the eastern part of the country represents from 25 to 35 per cent of the existing market price of copper. To state it another way, it costs from 3½c. to 5c. per lb. for transportation alone to deliver one pound of copper from the Rocky Mountain territory to the consuming territory adjacent to the Atlantic seaboard.

The railroads are really partners in any successful mining enterprise, and are the chief benefactors, without incurring financial risk. The mining industry of the country creates an enormous amount of traffic for the railroads, which ranks with the most desirable and profitable tonnage that they handle, due chiefly to heavy loading, minimum transportation risk and claim hazard, and ordinary dead-freight service. If transportation costs are excessive, production is necessarily curtailed, because these costs are reflected in the price of the metal and consequently in the use of it. On the other hand, if transportation costs are maintained on a workable

basis, the conditions thus created are likewise reflected in the price, which is made more attractive and creates increased uses for the metals.

The general industrial activity during the years of the war brought such a demand for metals that all the efforts of the industry were bent toward production. Mine development, usually carried on concurrently with production, was greatly curtailed. In all districts mines were depleted. When the demand suddenly ceased and prices were depressed, continued production was possible only under lower costs. Many mines could not afford the continued high labor and other costs, particularly when expensive development work was necessary, and were forced to close. Practically all of these mines are still inoperative. Their resumption of operation is dependent not only on metal prices but on lower production costs. When their problem is solved that of the ore-carrying railroads will, in a measure, be solved.

Resumption of work by the mines means greatly increased tonnages and revenue for the railroads serving them. Ore rates are principally based on the value of the ore—"the smelter returns to the mine or owner before deducting freight charges." These rates have, with few exceptions, been increased 62½ per cent since June 24, 1918. The lower grades, those under $15 per ton, have in many instances been readjusted to a basis 125 per cent of the rates in effect June 24, 1918, but the miner cannot increase the value of his product nor the metal content of his ores, and increased costs for fuel, labor, freight rates, and supplies make unprofitable the mining of even the higher grades of ores that formerly yielded a fair profit. An increased ore production would mean to the railroads increased revenues on ores, coal, coke, fluxes, fuel oil, bullion, and all those supplies required by a prosperous community.

Copper, lead, and zinc ores and their associated metals occur in deposits distributed throughout the world, and many countries produce the refined metal in large or small quantities. There are probably no basic commodities produced in the United States which meet with greater competition in foreign markets than these metals. The surplus production of the United States goes to Europe and to Asia in competition with this world production, which is produced principally contiguous to the seacoast and has the advantage of low-cost water transportation.

At present the rate on copper, lead, and zinc from Montana or Utah to the Pittsburgh district is $15.90 per ton, though the same product can be delivered at a lesser charge via the Pacific Coast to Japan, Germany, France, or England. The South American producer ships his copper product direct to Europe or to New York at the present time for $5 to $7 per ton, while our own Western producers pay $16.50 to New York refineries.

The consumer in Antwerp or Rotterdam gets this copper from the refineries at New York today at a freight cost of $3.50 per gross ton, which is 30c. per ton less than the rail rate from the same refineries to Philadelphia or Trenton. Copper shipped from the refineries at New York or Baltimore to Rome, N. Y., a large consuming point, pays from 60 to 130 per cent greater freight cost than is paid from the same points to Liverpool, London, Antwerp, or Rotterdam.

In Interstate Commerce Commission "64 I. C. C. re Grain, Grain Products and Hay," Commissioner Potter, in his concurring opinion, said:

"The fundamental trouble with the industrial and commercial affairs of the country is that there is insufficient production and costs are too high. The latter is the cause of the former. Production in this country at the present time is far below normal needs. If normal conditions could be brought about, the industries of the country could operate normally for a long period to take care of the markets of this country, to say nothing of the markets in other countries. Normal operation of the country's industries would furnish employment to labor generally, revive markets, and increase the general buying power which the country needs. A reduction of production costs is essential to this result.

"Freight rates are an important element of manufacturing and production costs. Railways are the carriers and conveyors which bind together the different departments of the great national industry in which the finished product of one individual industry becomes the raw material of another. In a large country like ours, with its long hauls and wide distribution of producing industries, it is obvious that the freight burden in its relation to other cost factors must be stable. A disturbance of the proper relation of the cost factors is bound to affect industry and may force changes and relocations which impair the general public and private interest. Until within the last few years the tendency of the factor of transportation cost in relation to other factors has been downward. Recently it has been upward, and it is now out of proper relation to other factors. Rates must be gotten back to the proper relation to other things. They must come down, and whatever is necessary to bring them down must be done."

# How Should a Mining Engineer Be Trained?

## Mining Engineering Covers the Broadest Field—Technical Mining Curricula in Throes of Experimentation—Selection of the Student Material Difficult—Cultural Subjects Desirable—Metallurgy Should Be Included

BY ALLEN H. ROGERS
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THE TRAINING of the mining engineer is the subject of much discussion at present, not only among educators but by the practicing members of the profession. Among the educators, the motive is mainly what to teach in the time available; among engineers the discussion is based on the feeling that technical school graduates are not properly equipped for entrance into the practice of the profession. It is generally felt that most of the graduates cannot successfully apply, in practice, the knowledge they have acquired in school, and that they have not enough of the culture and general information which the dignity of the profession requires. The schools do not graduate finished mining engineers; they turn out what may be called engineers in embryo, who require a period of apprenticeship before they become full-fledged engineers.

The field of mining engineering is the broadest of

all of those comprised in the divisions of engineering. Mining engineering is the application of science to the extraction of mineral substances, and in its practice the mining engineer is called upon to apply at one time or another the principles of all the specialized branches of engineering. When it is considered that the mining engineer, as manager of large operations, must also specify equipment, build railroads, plants, and towns, and operate them, it is easily comprehended that there is no branch of science which, as applied, is known as engineering, that the mining engineer cannot, with advantage, master.

Naturally, within a field so broad, there is much specialization in the practice of the profession. The economic geologist devotes himself to untangling the complicated processes of ore deposition or to tracing the structure of a petroleum pool. The metallurgist interests himself in smelting, leaching, or milling. Among mining engineers, in the popular acceptation of that term, there are specialists in placer mining, coal mining, and what not. Some of these specialists, particularly geologists, train from the beginning as specialists. Many, however, become specialists through practise in some one branch of the profession.

The mining engineer should possess a knowledge of geology and of general engineering combined with business and executive ability. Geology and engineering are based on the fundamental sciences of mathematics, physics, and chemistry. Business and executive ability are likely to be in proportion to the knowledge possessed of economics, sociology, and facility of expression. As a professional man, the mining engineer should also possess that culture which comes only with a knowledge of literature, history, and art. It is therefore apparent that the problem of educating the mining engineer is an important one. It must be more difficult than that of teaching any other branch of engineering, because it includes the fields of nearly all of them. Any problem existing in the teaching of other branches of engineering must exist for mining also.

Some years ago, certain national societies joined in forming a committee for the study of engineering education. This committee found the task beyond its capacities, at least for the study the subject merited. At their solicitation, therefore, the Carnegie Foundation appointed Prof. Charles R. Mann to study the subject, and his report is issued as "Bulletin 11" of the Carnegie Foundation. This report has been generally commended by engineers as a masterful discussion of present methods and conditions and as offering a wealth of constructive criticisms and suggestions for improvement. For some reason, hard to determine, its acceptance by teachers of engineering has not been so cordial. To one who desires to pursue this subject extensively, no better introduction is available.

## Comparison of Mining Curricula

More recently a study of mining engineering education has been made by a committee of the Mining and Metallurgical Society of America. Its report embodied a comparison of the time devoted to the various branches by different schools. The comparison was made on a percentage basis, and was confined to those schools devoting four years to the course, so that the figures might be approximately comparable on the basis of time.

The comparison was made under fourteen different headings. It disclosed a most extraordinary diversity of conditions, as a study of the accompanying table, summarized from Mining and Metallurgical Society "Bulletin 150," will prove:

DISTRIBUTION OF TIME ON PERCENTAGE BASIS IN TWENTY-FOUR AMERICAN MINING SCHOOLS (CURRICULA GENERALLY OF 1919–20)

| | Average of All Schools | Average of Those Specifying Subject | High | Low |
|---|---|---|---|---|
| Mathematics | 10.5 | 10.5 | 16.8 | 6.1 |
| Physics and mechanics | 9.2 | 9.2 | 13.2 | 4.0 |
| Mechanical drawing | 4.6 | 4.6 | 8.6 | 2.8 |
| Chemistry | 11.0 | 11.0 | 15.7 | 7.3 |
| Geology and mineralogy | 12.5 | 12.5 | 17.7 | 4.3 |
| Engineering economics and history | 7.2 | 7.9 | 18.8 | 2.0 |
| Foreign language | 2.6 | 5.8 | 7.9 | 3.8 |
| Surveying | 2.7 | 3.3 | 7.4 | 1.0 |
| Civil, mechanical and electrical engineering | 11.3 | 11.3 | 17.9 | 7.1 |
| Mining engineering | 11.1 | 11.1 | 19.1 | 4.4 |
| Metallurgy and ore dressing | 10.9 | 10.9 | 18.4 | 4.4 |
| Thesis | 1.0 | 2.4 | 4.3 | 1.0 |
| Physical training, military drilling | 3.1 | 5.0 | 10.5 | 2.3 |
| Electives | 2.3 | 6.1 | 20.4 | 1.3 |

Of these schools, two required no English; thirteen, no foreign language; fifteen, no thesis; nine, no physical training, and fifteen allowed no electives. There are also three which include no instruction in surveying, but require it at a summer school. The table, therefore, shows averages for all, as well as averages for such schools as specify the subject. It should also be stated that the "low" figure takes no account of the schools which do not include the subject in the curriculum.

As the amount of time devoted to a subject reflects the view of the faculty as to the emphasis placed on that subject in the education of the mining engineer, it is rather astonishing to note the wide variation between the high and low figures. A comparison of the figures of nineteen courses in metallurgy indicated similar conditions. Incidentally, no great difference between the courses in metallurgy and those in mining engineering was apparent.

It must be concluded from such a study that mining engineering education is still in the experimental stage, and it would appear that, generally speaking, the experiment is not being conducted in accordance with the principles taught by the very schools that are experimenting. In research, we are taught that we should know the materials with which we start, observe the conditions under which the experiment is conducted, varying one at a time, and make careful observation and record of the result. Engineering schools have not, in the past, observed these requirements in their experiment on education.

## Admission of Engineering Students

The only measure of the candidate's ability in the institutions covered by the investigation was the entrance examination, which, it is now admitted, indicates only a part of the student's ability and gives little clew to his real bent. As to methods of instruction, they change little. The course in mathematics made mathematicians. The course in chemistry made chemists. But none gave clearly the clew of their relation to engineering. Even in many engineering subjects prescribed, the mining engineering student found no reference to mining structures. Such methods have resulted in an overwhelming proportion of failures. Professor Mann states that of students entering engineering schools, over 60 per cent fail to graduate. No corresponding figure is available for mining engineering students, but it is certainly as large. The result clearly indicates a serious defect in the methods of determining admission or in the methods of instruction or both.

Furthermore, I know of no systematic record of the

attainments of the graduates. The men of outstanding prominence in the profession naturally reflect much credit upon the schools which educated them, but all schools can count such eminent engineers among their graduates. If we had a way of determining, after some years, an average grade for the graduates of the schools, there might be some clew to the best curriculum or the best school among the variety summarized in the foregoing table. Such is, however, apparently impossible. At any rate, it has probably never been attempted, and so, at present, out of all the experiments there is no measure of which is giving the best result.

Clearly, the problem is difficult, not only of solution, but difficult in devising means of solution. In its present state, it is one to which, apparently, only cut-and-try methods are applicable. There is no law known which can be applied to boys to determine whether they will make good engineers or not, nor can one say, off hand, that this method of instruction will give better results than that. But many are at work on both phases of the problem. In the endeavor to discover the particular bent of a boy, most colleges are now using tests which have been devised as a result of increasing knowledge of psychology. They are admittedly experimental, and, as yet, in no way supersede nor even, it is believed, supplement the regular admission examination. It will take a long time to evaluate these tests—whether they really mean anything or not—but by the limited standards of comparison so far available it is thought that their result will be to save many from spending several years in the study of a profession in the practice of which they are bound to fail. It is sincerely to be hoped that such may prove to be the result. Engineering schools, although many, are overcrowded, and every ill-adapted candidate who can be eliminated assures improved conditions for the student who is a born engineer.

### Advantage of Practical Instruction Methods

Regarding instruction methods, there is even less of theory on which to base an investigation of results. It is self-evident, however, that, for example, in the study of mathematics the student will be more interested if he learns the processes while working out a practical problem. Every one remembers with greater ease that which interests him than that which does not, so what is needed in instruction is to incite the student's interest. If the student really desires to become an engineer, he will take more interest in a subject if he applies his knowledge of that subject to an engineering problem, thus seeing its application, than if he does not. It should not be difficult to devise means of doing this in instruction in the sciences, and, indeed, it is being done to an increasing degree. In the study of English and other cultural subjects, it is more difficult, but even these are being successfully brought into line.

The underlying problem of the schools is, then, to select from the candidates offering themselves for admission boys who have a natural interest in engineering and to teach what is taught in a manner that will make the student realize that he is making progress in fitting himself to become an engineer. Apparently, this is now thoroughly appreciated by school authorities generally.

Most of the schools give a four-year course. Engineering schools were founded by colleges or college-trained men, so it was natural that four years should be selected for the course. Economic considerations will probably influence the determination of time also. The average boy is ready to enter college when eighteen or nineteen years old. Adding four years to this brings him to an age when he should become self-supporting. Of course, many boys do not have to consider this factor, and then, too, many support themselves in whole or in part during their colleges course.

### The Five- and Six-Year Courses

There are some institutions where the time varies. The usual engineering school year is from thirty to thirty-four weeks (not counting required summer work), making 120 to 136 weeks for the course. The Michigan College of Mines divides a similar number of weeks into three years. On the other hand, at Columbia University six years are required. The first three years covers studies, not only of subjects "considered fundamental in the study of engineering, such as mathematics, physics, chemistry, and the first courses in drafting and mechanics, but also such subjects as English, modern languages, history and economics," to quote from the publication of the school. On the completion of the three-year program and the first year's work in the Engineering School, the bachelor degree is awarded. With the completion of the further two years of work, the degree of Engineer of Mines is awarded. Thus, the school is distinctly a graduate school on the same plane as schools of law and medicine. A somewhat similar plan has been adopted at Stanford University, and Harvard has a five-year course, with, however, the difference that the work of the fifth year is in extension of the usual four-year course. Another course in what is known as mining engineering and business administration requires five years for completion. Encouragement for the success of such plans may be found in the increasing number of students who, after a classical course in college, either completed or in part, enter engineering schools. At the Massachusetts Institute of Technology, this year 38 per cent of the students are from other colleges, chiefly of the academic type. It would also appear desirable that a boy who finishes high school at or under the average age of about eighteen and a half, and who has not yet "found" himself (few boys at that age have), should continue his education along the purely cultural lines offered by the usual academic course. This gives him an opportunity to crystallize his ideas as to the vocation he wishes to follow, and, if engineering, he will be much more likely to undertake the necessary studies with the requisite earnestness and understanding. For the type of student noted, for the slow plodding boy who, though not brilliant, remembers what he learns and so finishes high school late but satisfactorily, and for boys to whom the financial burden of any absolutely unessential years would be impossible, the four-year school will always have a place. A great many colleges have the advantage of Government support, and it is doubtful if public sentiment, so long accustomed to consider the period of higher education as four years, could be influenced to favor six or even five years. It would appear, therefore, that the standard course in mining engineering will continue to be four years. There is room for the six-year course where the school is part of a great university, but there will be many students from other colleges who will choose the school of engineering giving the four-year course.

Other things being equal, the location of a mining school in the heart of a large mining district should be an advantage that requires no argument. The ability

to keep the student of other branches of engineering in constant contact with the kind of industrial operations he is learning to conduct is regarded as a great advantage by some and has resulted in such systems as that of the University of Cincinnati, in which the students work in neighboring industrial plants as part of their course. A somewhat similar course in electrical engineering is offered at the Massachusetts Institute of Technology. There may be some question, however, as to the length to which such a policy should be carried, for the object of engineering instruction is not to turn out skilled artisans and too much valuable time could be devoted to the bench and the lathe or, in the education of mining engineers, to running a drill or framing timber. On the other hand, there is no gainsaying the advantage to the mining student of being able to observe mining operations and taking part in them to some extent. Even those institutions far from mining operations require that time shall be spent at mines either at summer schools or as an employee. This, of course, follows the laboratory system of instruction, which has always been a feature of American technical schools.

In view of the broad field covered by mining engineering, there is probably no situation that would not lack some essential feature. Furthermore, as the field covers elements of all other branches of engineering, the general engineering school with liberal facilities for instruction in all branches of engineering offers advantages which offset those of situation possessed by the small mining school in a mining district. At any rate, that is the condition now. Whether the time will come when a great mining school with all the facilities will grow up in some mining district cannot be foretold. Mines are worked out in time, whereas the mining school will go on forever, so that even such a school might lose its advantage.

As to methods of teaching and what to teach, the first part of this question involves problems in pedagogy which I will not attempt to discuss. The endeavor, however, should constantly be made to make instruction more objective. What to teach within the limited time available in four years is another serious question. As indicated at the beginning, there is no item of engineering knowledge which a mining engineer cannot with advantage possess. Those of us of many years' experience can recall an almost limitless variety of problems which have come before us for solution. Some we solved easily; others with much labor. None would have stumped us if we could have looked up the necessary data and had the fundamental knowledge requisite to understand them when found. There is the gist of the whole subject—the fundamental knowledge requisite to understand a reference. It is hopeless for any but a few among us mining engineers to be finished railroad engineers, power engineers, mechanical, electrical or chemical engineers. But we should have the groundwork on which we can erect ourselves into temporary railroad, power, or any other kind of engineer, as the occasion arises.

### Thorough Instruction in Fundamentals

Instruction, then, in the fundamental sciences, mathematics, physics, and chemistry, should be thorough, and, as previously argued, as "practical" as possible. For mining engineering students almost any kind of engineering example will be useful, but it is important to make the use of the fundamental knowledge clear. The examples need not be many. A list of type examples, carefully selected throughout the fields of civil, mechanical, electrical, and chemical engineering, will give the student the knowledge of how to approach the solution of any problem. The principal thing is to teach him how to apply the fundamental laws—in other words, how to think.

For the mining engineering student, the important subjects in geology are the process of ore deposition and the structure of ore deposits. There is no need that he be made an expert in mineralogy, petrology, or historical geology. These are important in their field, but in consideration of the time schedule, only such stress should be laid on these subjects as will contribute to understanding ore deposits, their form, and the processes of deposition of the ore minerals. Contributory to this is, as with general engineering subjects, a knowledge of physics and chemistry, with the ability to work problems in descriptive geometry.

Another consideration will influence the choice of subjects to be taught, and that is the practical one of giving the graduate an equipment that will make him worth a salary immediately after graduation. It goes without saying that some description of mining and metallurgical operations must be given, although the need for this decreases where the opportunities of the student for observation of actual operations are many. He must have a picture of what mining engineering aims to accomplish, the special problems it faces, and the way in which some of them have been solved. He cannot be fitted to attempt solution of any such problems on graduation. He cannot at once plan or take charge of operations, but must fill some subordinate position such as assayer, surveyor, sampler, or other minor job. It is, therefore, desirable that instruction of the student include practice in commercial assay and chemical methods, surveying and mapping, and mechanical drawing. Furthermore, with few exceptions, graduates in mining engineering must generally accept whatever job may offer within the field.

### Insufficient Cultural Subjects

Finally, everybody is agreed that engineering students do not get sufficient instruction in such subjects as English, history, foreign language, economics, sociology, and law. It is generally recognized that the attempt to teach these subjects entirely detached from the technical courses accomplishes nothing. There are two reasons for this, the principal reason being the lack of interest on the part of the student, and the subordinate one the lack of time to do justice to courses in any of the subjects. But here again, as with general science, methods are being worked out to teach these subjects co-operatively with engineering subjects. Instruction in English, for example, may be continued throughout the course by requiring the submission of reports and exercises to the English department for review and discussion.

Engineering may be termed commercialized science. An engineering project is not warranted unless the product is worth more than its cost. Thus, the principles of economics are fundamental to engineering. History, sociology, and law are subjects a knowledge of which is of the utmost importance to the manager of a mining enterprise. Opinions as to the desirability of instruction in foreign language differ widely. The possession of the ability to speak and write a foreign language, particularly Spanish, is unquestionably an

advantage to the mining engineer. It is questionable, however, whether the limited time in the four-year course permits of elementary instruction in foreign language. Such is properly a part of the preparatory school curriculum. That the student may keep up the knowledge so acquired, however, the engineering school can properly devote some time to the reading of scientific articles in a foreign language.

It seems to me that the keynote in outlining a four-year mining engineering curriculum should be less specialization and more fundamentals. Furthermore, the curriculum should be designed to form the foundation for the practice of both mining and metallurgy. It is only with extension of the course to five or six years that specialization should be permitted. Practice of mining engineering in its fullest sense is inconceivable without such knowledge of metallurgy as will determine the disposition of the ore. In other words, metallurgy is a specialty in the field of mining engineering, and there should be but one curriculum for the four-year course in mining engineering.

When the mining engineering student is graduated, he fancies himself a mining engineer, although he is not. He is encouraged in this belief by the fact that the degree has very likely conferred this title on him. This is unfortunate, and schools conferring the degree of Mining Engineer should change their practice, even in the cases where the degree is the result of six years' work. Bachelor, Master or Doctor of Science in Mining Engineering would seem to be the proper designation.

### The Mining Engineer's Career After Graduation

The job offered to the mining engineer on graduation, if any, is likely to be as assayer or surveyor at a mine or smelting works. Possibly the only opening available may be as a laborer. Many believe that some experience at shoveling or at pushing a car underground is a desirable feature of the young mining engineer's apprenticeship. In my belief, the most desirable positions are those of assayer or surveyor. The position of assayer gives the apprentice engineer, as we may now designate him, the opportunity to learn the characteristics of the ore, its sampling in the mine, its metallurgy, and its realization. As this comes to him naturally in carrying on his work, the knowledge and experience are never forgotten. In the position of surveyor, the novitiate has the opportunity of observing and discussing the development layout, the stoping method and progress of the work in all its phases. He will, at the same time, be using his geological knowledge and he will gain a good deal of information as to methods of handling men through observation of results attained under the conditions of the particular organization. A man who simply works as a laborer underground has an extremely limited horizon. He is likely to get so physically tired that his mental processes are dormant, and his close association with men mentally and morally his inferiors can only result in lowering his standards.

The first years of the young mining engineer's experience are likely to be trying, under any circumstances. Here is the young college graduate, with, perhaps, his character hardly formed, thrown into rough and uncouth surroundings, with few influences for refinement and culture—perhaps none. Maybe now the conditions are not quite as bad as they used to be. Looking back at the old-time mining camp, it is marvelous that the boys who went to the dogs were so few. Anyway, the older engineers should encourage their young subordinates to keep up their moral standards and to stimulate their interest, not only in the technique of the work, but in good literature, economics, and the political happenings of the day.

Means for physical exercise are an excellent influence. A tennis court costs little, compared with the benefit it confers in affording means of venting some of the physical exuberance of young men who are otherwise prone to give it expression in dissipation. The larger mining companies are realizing the benefits resulting to them by provision for such activities, and so provide club houses and libraries, tennis courts, and golf courses. For smaller operations also such a policy should be carried out, even though on a smaller scale.

# Department of Mines and Its Effect on Taxation

## Excessive National Debt and Consequent Taxes Best Met by Development of Latent Resources—Population Increase Requires the Pushing Back of Frontiers of Public Domain—Department of Mines With Cabinet Representation Essential to National Progress and Development

By Samuel D. Nicholson
Senator, State of Colorado, Washington, D. C.

ALL WARS ARE COSTLY and leave in their trail huge debts and interest charges to be paid by the generations that follow. The need for immediately increasing national revenue to meet these pressing obligations, leads first to the formulation of tax laws which impose the burden entirely upon the incomes of the people and on going industry. Little thought is given to the development of national assets, such as the natural resources of the public domain from which revenues may be derived to lessen materially the tax burden. Yet in times past the expansion of development upon the public domain has proved of vital assistance not only in reducing taxes and liquidating war debts but also in bringing about our phenomenal industrial growth and a condition of general prosperity.

The people of this country have at no time been confronted by such a heavy burden of debt and interest as that which now exists. The interest-bearing debt increased, in round numbers, from $1,000,000,000 in 1913 to $24,000,000,000 in 1920, and the annual interest charge from $23,000,000 to $1,000,000,000. The per-capita debt increased from $10.66 in 1913 to $288.63 in 1920, and the per-capita annual interest charge from $0.24 to $9.55. The revenues to meet these interest charges, sinking-fund accounts, and current

expenses for government maintenance and operation are now practically all derived from taxation, a crushing load for our people and industry to carry under present conditions.

### Expediting Development of Latent Resources Essential

Attention may well be directed to the public lands with a view to expediting their development and thereby increasing the direct revenue to the Government. Exclusive of public domain set aside for national parks, national monuments, Indian reservations, Carey Act withdrawals, and the Territory of Alaska, there are 200,300,000 acres of unappropriated land and 154,142,000 acres of forest reserve still owned by the Government. This total of 354,442,000 acres represents about one-fifth the area of the United States, and is more than eight times as great as the area of the New England States and nearly double the area of the thirteen original states of the Union.

Alaska, practically all public domain, is in area about one-fifth that of the United States. There is in public lands, therefore, an area equal to 40 per cent of that of all of the states in the Union, rich in agricultural, stock raising, timber and hydro-electrical power resources, coal, oil, copper, lead, zinc, gold, silver, potash, phosphate, and many other minerals, to be developed. These unappropriated public lands and forest reserves are situated in thirty-three states and in the Territory of Alaska, which indicates how broadly they are distributed. Any program to assist the discovery, exploration, and development of these resources will benefit not only the Government but also the many states in which the lands are situated.

President Harding, in his address to the Congress of Dec. 6, 1921, made the following reference to the public domain, indicating how seriously he considers the necessity for expediting the development of these natural resources:

> "Under what is known as the coal and gas lease law, applicable also to deposits of phosphates and other minerals on the public domain, leases are now being made on the royalty basis, and are producing large revenues to the Government. Under this legislation, 10 per cent of all royalties are to be paid directly to the Federal Treasury, and, of the remainder, 50 per cent are to be used for reclamation of arid lands by irrigation and 40 per cent are to be paid to the states in which operations are located, to be used by them for school and road purposes.
>
> "These resources are so vast, and the development is affording so reliable a basis of estimate, that the Interior Department expresses the belief that ultimately the present law will add in royalties and payments to the treasuries of the Federal Government and the states containing these public lands a total of $12,000,000,000. This means, of course, an added wealth of many times that sum. These prospects seem to afford every justification of Government advances in reclamation and irrigation."

A general conception of the value of the resources of our "national estate" may be gained from the estimate, presented in the recent report of the Secretary of the Interior, of a minimum ultimate value of $150,000,000,000. Based upon the mineral and oil leasing laws, the eventual revenue derived from royalties in the development of the mineral resources is estimated at $12,000,000,000. In this estimate, the realizable value of the timber, agricultural, and hydro-electrical resources of the public domain is not included. The estimated value here presented must be conservative, because it does not take into account the value of mineral discoveries yet to be made in an area which so far has only been superficially prospected. And no one can estimate the additional revenue yield that will result as general industrial activity expands, as it must, with the creation of new wealth.

During the last thirty years, the population of the United States proper increased about 43,000,000. One of the best assurances that any proposal to expedite the exploration and development of the resources of our public lands will be successful is the future increase in our population. Not only will man power be available to perform this work, but the increased demand for the products of the soil and mines, occasioned by this increased population, will create a home market to absorb the increased production. In fact, how will it be possible to satisfy the demands of the increased population unless the frontier of our public domain is pushed back by expansive development, making available these natural resources?

The problem, therefore, is not only a matter of lessening the tax burden by otherwise increasing governmental revenue, but also of meeting the requirements of a growing and progressive nation. The wealth of our public domain is chiefly mineral. As the total anticipated income to be derived from the sale of desert and semi-arid lands, grazing lands, and grazing and forage lands included in the public domain outside of the national forests, and grazing lands, timber, and other resources included in the national forests, is estimated at $1,310,000,000, while the income from royalties to be derived from the development of coal, oil, oil shale, phosphate, and potash, is estimated at $12,387,000,000, it is apparent that the problem of realizing upon these resources is almost exclusively one of mineral development.

I have previously shown the need at this time for a Department of Mines to insure the progress of our going industry by developing operating improvements as world competition becomes more keen, to study the subject of marketing as specifically applied to the products of our mines, to study the problems of the coal industry to avert public suffering when the machinery of production and distribution for any reason breaks down, by better co-ordinating the present governmental activities in the mining industry to render a more extensive and constructive service, and, finally, in providing a Secretary of Mines as a member of the President's Cabinet, who could devote his time exclusively to the solution of the many complex problems confronting the mining industry, and who could assume, on behalf of the administration, the responsibility of all matters pertaining to mining. I wish now to urge the importance of creating a Department of Mines, that the development of our "national estate" may be expedited as an effective means of lessening the tax burden, in addition to other advantages. It is well known that the present tax burden is exerting, and will continue to exert regardless of the system employed for its levy, a repressive influence upon industry and initiative. The development of revenue from these sources of new production, converting as it does a dormant resource into an active, national asset, is a constructive enterprise.

The bill which I have introduced, S. 1957, which provides for the creation of a Department of Mines with Cabinet representation, is designed to accomplish the best results in the development of the mineral resources of our country.

# Legislation and the Mining Industry

## What National and State Law-Making Agencies Have Done and Can Do To Benefit or Hamper Development and Prosperity of Mines—Need of Protection for the Gold Producer—Creation of Department of Mines Warranted by Importance of Industry

BY M. C. RHODES
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WHEN PRESIDENT HARDING, in his inaugural address, declared for more business in government and less government in business, he struck a high chord in the minds of the American people. The President evidently meant to warn Congress against the passage of such laws as impose hardships upon the individual citizen and the business world, and did not say that legislation necessary to encourage the basic industries of the country was not justified.

The development of the national resources of the country is one thing, and their conservation is quite another. We often hear the expression that our resources are unlimited, but, as a matter of fact, they are limited. Therefore, it is the plain duty of Congress to safeguard the welfare of the nation by aiding the economic development of our mining resources and their conservation, because the supply at hand must serve both present and future generations. Our country has grown from a mere handful of people, in the thirteen original colonies, to a population of 105,000,000 whose present needs far exceed those of the past; and with an ever-increasing population, the wants of the future will correspondingly multiply.

What legislation can do for the mining industry in the future can best be judged by what it has been doing in the past. By act of Congress, the Bureau of Mines was established in 1910 for the purpose of scientific research and experimental work in mining and metallurgy and to reduce the number of mine accidents by aiding, in an advisory capacity, the mine operators of the country in working out their safety problems. Coincident with this every state in the Union interested in either coal or metal mining, and not then having a department of mining, promptly enacted a code of mining laws. Through the operation of our state and Federal mining laws, the number of mine accidents in recent years has greatly diminished, the death rate among working men has been reduced, working conditions have been made more easy, and their health has been improved.

By a well-directed system of instruction and education carried on by the Bureau of Mines, workmen and operators have been taught how to avoid accidents, and have been brought into a closer relationship, the result of which has had a large influence in creating the nation-wide movement in all industries with respect to greater human safety. There were fewer fatalities in mine accidents in the United States in 1920 than in any previous year.

The United States Bureau of Mines during the Great War assisted the development of the radium industry in the United States. Prior to 1914 no radium had been produced in this country, and up to that time we had been dependent upon Europe for our supply. In 1914, the National Radium Institute was founded by Dr. Howard A. Kelly, of Baltimore, and Dr. James Douglas, of New York City. The Bureau of Mines entered into a co-operative agreement with the National Radium Institute for the purpose of making a scientific and technologic study of the recovery of radium from carnotite ores. Dr. R. B. Moore, of the Bureau of Mines, took charge of the work. Up to that time, large quantities of radium had gone to waste in the production of metallic vanadium and uranium salts.

A plant was established at Denver, leases were obtained upon lands in Colorado, containing radium ores, and by 1916, when the books of the National Radium Institute were closed and operations discontinued, 8½ gm. of radium had been produced, worth today over one million dollars. The Government's share of the amount recovered was 2 gm. Of this amount, the Bureau of Standards has about one-half a gram, and the Bureau of Mines has one-half a gram, now in the laboratory of the Mining Experiment Station at Reno, Nev., where further experimental work is being carried on upon radium and other complex ores. Of the remaining amount, the Bureau of Mines loaned about one-half a gram to Dr. Howard A. Kelly, of Johns Hopkins University, and one-half a gram to the Memorial Hospital, of New York City.

Up to Jan. 1, 1921, 115 gm. of radium was the total amount produced in this country. As a result of the impetus given the radium industry through the new discoveries made by the Bureau of Mines, and the dissemination of the information thus obtained by the publication of certain bulletins on the subject, private enterprise became interested in the matter, and today American manufacturers are producing ample radium to meet our requirements. In fact, the United States is producing more radium than all the rest of the world.

### OIL-SHALE INVESTIGATIONS

Another example of what legislation can do for the mining industry is shown in the experimental work now being carried on for the recovery of oil from shale and the elimination of waste in the handling of petroleum and its products by the use of scientific methods. Oil experts are of the opinion that our reserves of petroleum will be exhausted within the next twenty-five years. If this becomes true, we will be forced to look to other sources for our supply. It has been determined that shale oil can be successfully recovered from the Colorado and Utah shale at an approximate cost of $3.50 per bbl. Geologists are agreed that large deposits of oil shale are situated in Colorado and Utah. Oil experts hold that the potential supply of shale oil exceeds the supply of petroleum. If this is a correct view, the only remaining question to be considered is how to bring the price of production down to a reasonable figure.

It is true, from a practical standpoint, that no market can be found in this country for shale oil at $3.50 per bbl. so long as petroleum can be obtained at $1.50 per bbl., or at any other price below the cost of pro-

ducing oil from shale. However, Scotland has produced shale oil for seventy years, and is producing it today, at a cost of about $4 per bbl. None is produced for export, the entire amount being used for domestic purposes.

Experiments are now being made for the recovery of oil from sand, tar, and asphalt in the hope that, as the supply of petroleum is depleted, a process may be worked out by which oil may be recovered not only from shale but from these other sources. It is thought that the possibilities for the recovery of oil from oil sands are equal to the possibilities of recovering oil from oil shale.

Under the operation of the recently enacted oil-leasing law, the Government has provided a force of expert oil men to take charge of the oil-leasing stations in Colorado, Wyoming, California, Oklahoma, Texas, and Louisiana. These men go into the field and assist, in an advisory capacity, the more inexperienced operators in the bringing in of oil wells, so as to avoid as much waste as possible. The oil operators, like the coal and metal-mine operators, welcome the assistance the Government is rendering in this respect.

Another instance of what legislation has done for the mining industry is in the operation of the Pittman Act, which became effective April 23, 1918. Under this act, the Secretary of the Treasury is authorized, through the Director of the Mint, to purchase silver produced by the silver mines in the United States at the fixed price of $1 per oz. delivered at the mint, either in New York, Philadelphia, or San Francisco. Though the American silver miner has not received less than $1 per oz. for his silver since the passage of this law, foreign silver since April 23, 1918, has sold for less than 50c. per oz. Had it not been for the existence of this legislation, American silver would possibly have gone as low as 50c. per oz., and this would have resulted in closing practically all the silver mines in the United States in 1919. The effect of closing the silver mines would not only have thrown thousands of men out of employment, but would have also reduced the gold supply, as there is a recoverable amount of gold in many silver ores.

Briefly stated, legislation is conserving our forests, reclaiming arid lands, propagating rare seeds and plants, stimulating industry, and making life worth while.

So much for what legislation has done. Now, let us turn to what legislation can do for the mining industry. On account of the alarming reduction in our annual output of gold since 1915, there has arisen a demand in some quarters for legislation to increase the price of gold. The total gold production in the United States in 1920 was 50 per cent less than the 1915 production. Our 1920 production was 2,395,000 oz., being a reduction of $10,000,000 over the preceding year, and if it had not been for the abnormal importation of gold into the United States during the last three years, our gold reserve would have been reduced to the danger point.

During the recent period of high prices gold was the only commodity that did not advance in value, though the price of labor and material increased from two- to four-fold. In fact, every factor entering into the cost of producing gold increased, the price of gold remaining fixed at $20.67 per oz. Many Western gold-mining operators assert that on account of this fact they have been compelled to close their mines permanently. This situation gave rise to the introduction of the McFadden Bill, proposing an excise tax of 50c. per dwt. for a period of five years upon all gold going into the fine arts.

The Treasury Department does not look with favor upon the proposed legislation, upon the ground that the effect would be to disturb the gold standard by raising the price of gold from $20.67 to $30.67 per oz. Friends of the bill contend that the legislation is justified as a temporary measure, at least, to revive the languishing condition of the gold-mining industry. Recent reports from California, Alaska, Colorado, South Dakota, Montana, and Arizona indicate the industry urgently needs rehabilitation. Unless there is a decline in the cost of producing gold, it will be necessary in the near future to enact legislation of some kind in behalf of the gold-mining industry.

Gold mining is not a casual industry, and cannot be intermittently suspended and resumed without serious interference with production. It is a well-known fact that the high-grade gold-ore reserves are being rapidly exhausted, and unless science can open the way by which the gold content of low-grade ores can be successfully recovered, the time is near at hand when legislation must be enacted to relieve the unfavorable condition of the industry.

Those who oppose change in the existing law should be reminded that the downfall of empires and republics in the past has been brought about by failure to meet new conditions. The virility of this Republic lies in its ability to meet by legislation the new and ever-changing industrial and economic conditions. The decrees of ancient Venice were considered irreversible. One writer in speaking of the laws of the Medes and Persians in their day said, "They altereth not, neither do they change." That condition does not exist in our Republic. Our growth and development have been brought about by the law of evolution. Growth, development, and expansion are made possible by the law of healthy change.

Another question related to the proposed gold bonus legislation should also be mentioned. Under existing law, there is nothing to prevent the destruction of gold coin for use in the arts. In 1919, $80,337,600 worth of gold coin and bullion were sold by the United States mint for use in the arts, of which $3,500,000 consisted of gold coins of various denominations. In other words, five-, ten-, and twenty-dollar gold pieces were actually melted up and destroyed. It is estimated that at least $8,000,000 in gold coins were thus destroyed in 1920.

Another important fact in connection with the use of gold in the arts is that the gold production in this country in 1919 was $21,848,000 less than the amount consumed in the arts and manufactures in that year. Congress has no right to prevent by law the use of commercial gold in jewelry and industry, but Congress should prevent the destruction of gold coins for such purposes, and legislation to accomplish this is before that body.

Last but not least, in the consideration of legislation necessary to stimulate the mining industry, is the creation of a new executive department to be known as the Department of Mines. It is entirely inconsistent with the importance of the mining industry, in the light of its contribution to our whole economic structure, to relegate the indispensable function of government (as is true today with the Bureau of Mines) to a small department in a secondary Cabinet office. Our total output of mineral wealth in 1920 was $6,707,000,000. With one-half of the world's output of coal, iron, and steel, and of many other mineral and metal products, are we not entitled to a Department of Mines in the President's Cabinet?

# Editorial

## A Quiet Circumspection

WE LOOK BACK over the most lethargic year in mining which we have seen in our generation. The reaction from the stimulus of the World War has rested heavy upon us; and the convalesence of the world has been as slow as the devastating fever was sudden and fierce. We recall what Hoover said recently in Washington, that Europe was doing about as well as a wounded man could be expected to do; and that he believed that legislation and governments should apply disinfectants, and leave the patient alone; that it was no time to apply poultices. What Hoover said of Europe applies pretty well to the United States; and we need to be treated gently and left alone as to legislation, rather than that a stimulation should be attempted, to set up an artificial strength which the patient is not yet able to maintain. Many of our troubles have been legislative troubles; but one of them, the excess-profits tax, has happily been recently abolished.

Undoubtedly we are one year nearer the resumption of mining activity than we were at the time of our last New Year's number, yet the rise of the curve, though unmistakable, has not yet been striking. Copper, lead and foreign silver stand at about the same prices as a year ago, and zinc is decidedly lower. The lesser mining industries are sleeping as soundly now as they were then. Only the gold industry has worked into a decidedly improved position, on account of the constant lowering in cost of supplies and labor. For the moment, gold mining should absorb all our surplus mining activity. Gold properties should be purchasable at reasonable terms, and operation should show a steadily increasing profit. Though this is true of the gold mines of the United States, which suffered most during the war, the rise in dollar value of the pound sterling, from 3.53 to 4.20, has wiped out a considerable part of the "premium" enjoyed by the South African mines, whose prosperity has dwindled accordingly. Also, the rise in Canadian exchange, from a discount of Canadian currency over United States currency of 17 per cent discount to 4 per cent discount, nearly wiped out whatever advantage Canadian gold mines possessed a year ago, in selling their gold in the United States.

In the copper situation, it is probable that much of the scrap which came from the wreckage of war, and which so paralyzed the market for new copper, has been absorbed. Yet, despite the shutdown of a large portion of the producing mines, the copper stocks have been by no means used up; and some of the operating mines, like Chile Copper, have been keeping on at a loss. The fact is that the consumption of all sorts of metals and minerals is moving back very slowly indeed toward healthy conditions. For example, the stocks of tungsten now in the country, accumulated during the later days of the war, will last the country at the present rate of consumption for three years, without further domestic production or import. Of little use, then, to worry about legislation regarding tungsten mining. And this is typical of general conditions.

Resumption in building activity is very slow; the housing shortage has not been remedied. The railroads are still doing a very slack business. Times are hard with the farmers, for the prices of food supplies have fallen; hence there is altogether little buying power. Industries which are an index of prosperity, like the automotive industries, are having fairly hard periods of adjustment.

Yet the general symptoms are those of progressive recovery. Not only have the exchanges of Great Britain and Canada moved in the direction of parity, but the French franc, whch was worth only 5.8 cents a year ago, has advanced to 8 cents; and Italian lire have risen from 3.40 to 4.20. Thus the solvent European nations are recovering. On the other hand, the mark has dropped from 1.30 cents to 0.53 cents, emphasizing the progress of the bankrupt European nations toward the inevitable reorganization. The forthcoming European economic conference should help this. Despite her further depreciated currency, German trade has increased, and in 1921 she bought three times as much copper from us as she did in 1920.

The Limitation of Arms Conference has accomplished a good deal toward the securing of that future peace which is the prime requisite toward prosperity; and we may look forward to a period of peace both with Asia and Europe. The solidarity of the United States and Great Britain evidenced by the Conference was one of the most satisfactory signs. At the same time, political turmoil is not yet at an end, especially for Great Britain, as evidenced by Ireland, India and Egypt.

The buying power of the world has been paralyzed by taxes which have been imposed to meet the cost of war. One cannot spend a dollar for taxes and also spend it for commodities. And a large part of these taxes go to meet the interest on debts incurred in the war; and the repudiation or failure to meet national debts, such as those of Russia and Mexico, has more or less permanently engulfed large portions of the world's productive capital. The Limitation of Arms Conference promises us the first step in the direction of a cessation of tax increase; we even have in our new tax law some marked decreases. In the end, we must ascribe taxation as the main malady of the country and the world. Reduction of taxes will bring us prosperity; not the imposition of tariffs, which in the endeavor to stimulate one industry will impose on all the rest that added taxation which paralyzes all industry and shrinks buying power.

The tax on incomes has been slightly abated, yet not enough to let loose capital in normal amounts from business enterprises; and the colossal blunder of tax exempt securities forces that capital disaster, the growth of a class who live on their interest, but do not risk their capital in productive enterprises—a class the development of which is not normal to the

American spirit. Piecemeal legislation, such as the exemption from income tax of money invested in mortgages, as in Massachusetts, has feebly endeavored to fight against this condition. The new Federal tax law removes the excess-profits tax; but there were no longer excess profits of importance to collect.

There is only one gospel for the world, one formula for prosperity: Peace, good will, work, production, thrift, simplicity. All this will make business, consumption, the opening of mines, and good prices for metals and minerals. And the maintenance of navies and armies, the general striving to escape effective and productive work, the congestion of population into the cities, extravagance, the lack of thrifty habit, greed, class strife, will make toward poor business, little general consumption, the paralysis of the demands for metals, and low prices for all produced commodities.

# The Moment Position of the Mining Industry

## Resumption at Butte Promising—Wages and Supply Costs Dropping—Labor Sufficient and Quiet—Freight Rates High —Gold and Silver Camps Active—Lead-Zinc Districts Busier

BY A. H. HUBBELL
News Editor, *Engineering and Mining Journal*

THE OUTLOOK for the metal mining industry is certainly more cheering than it was a year ago. Optimism expressed then had a hollow sound, more often than otherwise the wish being father to the thought. It was prophesied that fall would see a decided improvement in copper operations. This not materializing, the date was set ahead to spring, and now apparently the revised prophesies are in a way of being fulfilled. The resumption of work, even on a limited scale, at Butte, and that just announced to take place April 1 in northern Michigan, indicates that the operating corner has been definitely turned, just as the corner in price was turned in August. Hence present optimism appears well founded, though a recovery to normal will probably be a much slower process than many anticipate.

Fortunately for those whose well-being depends largely on the mining industry, the long period of depression in the copper camps has not been paralleled by as marked a depression at the same time in localities where some of the other metals are produced, particularly gold and silver. Those engaged in iron mining have been hard hit, and still are, particularly on the northern ranges, though even they have been more fortunate than those who ordinarily live by mining copper.

At the present time, there is considerable activity in most of the important districts of the country, except the copper camps and the Lake Superior iron country. Likewise in northern Ontario. Costs are still high, though they are improving, as wages decline with prices of supplies. High freight rates are in general a cause of complaint, and are acting as a decided deterrent to production, though with base metals this is not an unmixed evil. Inadequate smelting facilities are another source of discontent, particularly in Colorado.

From the operator's point of view the labor situation is good. That is to say, in most localities at least enough workmen are available for the operations, and the men appear to be of docile temperament. The agitator has practically disappeared, though it is too much to expect that he is gone for good. The year just ended has been notably free from disturbances such as those of 1919, in which year no less than twenty strikes occurred in as many different mining communities. The strike at Tonopah which began in April, and that at the Premier were the only ones of any moment, and at present every camp is quiet.

Unemployment, a bogey reared a few months ago, has proved devoid of sensational features, so much so that it is easy at a distance to deny its existence. There have been however, and are, many men out of work or receiving only a fraction of their ordinary income, particularly in the Lake Superior district and in Montana, though community pride as well as personal pride does not like to advertise the fact. In some camps, especially in the Southwest, many have left with their families for other districts, often at a distance, a fact that must needs be considered when time permits resumption. In sections adjacent to farming communities, a labor surplus is not readily noticeable even in winter.

Wage scales in districts where curtailment is marked are largely nominal and tell nothing as to the income of the miner, owing to part-time or split-shift operation. In general, even in districts that are fairly active, wages are lower than a year ago. Utah operators followed a 25c. decrease on April 1 by another of 50c. on Jan. 1. In the Coeur d'Alenes, a cut of $1.25 to $1 was made last January. New Mexico mines announced a new and lower scale. Likewise in Colorado a general cut from $4.50 to $4 was made, and it was the decrease from $6 to $5.25 at Tonopah and Divide last April that was the principal cause of the strike there. The scale was lowered at Grass Valley early in the summer and many other like reductions can be cited. To some extent this situation has been eased by a decrease in the cost of living, though this has lagged behind wages in falling, as might have been expected.

Supplies cost less on the average, Dun's index number of commodity prices being $164.444 on Jan. 1, as against $247.394 on Jan. 1, 1919; $198.609 on Jan. 1, 1921, and $159.833 on July 1 last, which was the low point of the past year, since when prices have advanced slightly. The cost of powder still seems unduly high to some operators.

Although freight rates are still regarded as hampering operations, the situation is easier in some localities than it was a year ago. The Utah Public Utilities Commission has exempted shippers within the state from paying the 25 per cent increase that became effective throughout the country on Aug. 26, 1920. Lower rates have been allowed on ore shipped to the Bunker Hill, East Helena and Northport smelters and between the Plumas County copper districts, in California, and the Thompson smelter in Nevada, which has not yet resumed. The El Paso & Southwestern R.R. has made reductions on ores shipped to El Paso and Douglas. Likewise, rates have

been lowered on bullion between Western points and the Atlantic seaboard, this probably as a result of shipments having been made via Panama. Other reductions have been made and still others are asked for or anticipated. Numerous shutdowns resulted directly from the advances in rates. In some cases whole districts were paralyzed; so much so that the railroads themselves suffered more than they gained. Likewise the smelters were affected. As rates improve, therefore, it is expected that this process will reverse itself. But much remains to be done.

Thus the general situation of the mining industry is promising. Business may be bad in spots, but sentiment is good. A survey of conditions in the various major districts tends to strengthen this belief. We make an exception in respect to the copper camps outside of the Butte district, to which reference has already been made; for truly there is little activity here to point out.

The so-called "porphyries," meaning the Ray Consolidated, Chino, Utah, and Nevada Consolidated companies, are doing little except keeping their mills in running order. An official of the Utah company recently said rather vaguely that his company might resume April 1. In the Southwest, the copper camps are shut down save for the New Cornelia and Miami companies, which are producing at the approximate rate of 2,200,000 and 4,500,000 lb. per month respectively, and the Superior & Boston, which recently resumed. The International smelter is running a furnace on Miami concentrates. The other important companies now shut down are ready to resume when market conditions warrant, though it will take time to build up forces.

In California, the Shasta copper belt is dead. The Plumas County district is active, the Engels company, which is the most important operation, producing steadily. Granby, in British Columbia, is making an excellent showing. In the two important copper-producing sections of the East, namely northern Michigan and the Ducktown district of Tennessee, the former is producing refined copper to about a third of its normal output. Copper stocks awaiting shipment there are dwindling, and Calumet & Hecla, Ahmeek, Allouez and Isle Royale will resume production at about half normal on April 1. The two producers of the Ducktown district are both operating, one of them, the Ducktown Sulphur Copper & Iron Co., at full capacity, the other curtailed.

It sounds like working a worn-out pleasantry overtime to say that silver remains the bright spot in the metal-mining field. Had it not been for the Pittman Act, conditions in the last two years would surely have been much worse. This, of course, applies to the camps within our borders. Canada has been less fortunate, though the improvement in the price of foreign silver has made producers in Cobalt and in the districts of British Columbia more optimistic. At present production is about normal at Cobalt. Conditions have been bad in British Columbia, but are looking better, now that the Trail smelter will settle promptly for custom shipments.

Utah remains the leading silver producer of the country. Park City and the Tintic district, centering at Eureka, are maintaining a steady production that is approximately normal, sometimes above and sometimes below. Bingham is producing lead ore of milling grade and iron sulphide ore for fluxing purposes, the output last month having been about 15,000 or 16,000 tons. The Tooele smelter is down, but the other three in the Salt Lake Valley are running, Midvale and Murray on lead, and the one at Garfield, normally a copper plant, principally on siliceous silver ores.

Conditions in Nevada are considered satisfactory. Tonopah, a silver-gold camp, as well as Divide, is producing normally. Developments at the "boom" camps of Royston and Silver Horn are promising. The Pioche district has suffered severely from high freight rates, but is looking forward to some relief, reductions to be effective soon having recently been granted by the Union Pacific, following a hearing at Carson City. Development and construction work of importance is under way at Virginia City and American Flat. The Randsburg silver district in California has been active.

When one discusses silver camps he soon finds himself talking about lead, lead naturally leading to zinc, because of the frequent association of these metals. In the Cœur d'Alenes, in northern Idaho, normally producing all three metals, but three producers are active, the Hecla, the Morning (Federal), and the Bunker Hill & Sullivan, their output being about normal. In all about 2,500 are employed in the district, with few idle. The last-named company is making an increased production of lead. The entrance of this new smelter into the northwestern field, as a competitor, will benefit the small producer. Early resumption by the Tamarack & Custer and the Hercules is anticipated.

The Consolidated smelter at Trail is handling a normal tonnage, mainly from the company's mines. In districts in the Pacific Northwest, other than those noted, the situation is quiet, though the outlook is promising. Magnesite mining in Washington is dormant. The Tacoma smelter is running at reduced capacity and that at Northport is shut down.

In the Joplin-Miami lead-zinc district, about sixty mines are operating, against half that number a few months ago. Production is about 7,500 tons per week. In the Wisconsin zinc-lead district, there is said to be no curtailment. Five producers are active; also a roaster, an acid plant and an oxide plant. In the southeast Missouri lead district, operations are at about two-thirds of capacity, with production tending to increase.

The gold camps of Porcupine and Kirkland Lake, in Ontario, are scenes of great activity. The Hollinger, at Porcupine, has been breaking its production records and would doubtless do better could it get more power. In the Black Hills of South Dakota, the Homestake and Trojan are producing at capacity. In Colorado, much exploration and development work is under way, especially in Cripple Creek and in districts where gold and silver predominate. Winter conditions have hampered this to some extent. In general, conditions are better. In California, gold mining is improving at lode, drift, placer, and dredger properties. Grass Valley, Plymouth, Sutter Creek, Jackson and Melones are approaching normal, and there is some activity further south.

Nickel production in the Sudbury district, Ontario, is limited to the curtailed output of the Mond company.

The past season has been the worst in many years in the Lake Superior iron country. Winter conditions, when operations normally slacken, now prevail.

The Birmingham district, in Alabama, appears to be getting under way with iron-making conditions steadily bettering. The largest producer there is running at two-thirds capacity. Thirteen stacks in the district are in blast, compared with five six months ago. All things considered, the present situation warrants optimism.

# Market Comment

## The Outlook for Copper

By Joseph Clendenin
Sales Manager, Guggenheim Brothers, New York

THE OUTLOOK for copper in 1922 and for years to come is distinctly good, in so far as consumption is concerned, for consumption is bound to increase. The outcome to the mining companies, for stockholders and employees alike, depends largely and primarily, however, on the rate of production that will be maintained, for that will affect not only the cost of the output but also the price that will be obtained for it. Table I gives the production of the mines of the United States in the three years immediately preceding the war, under normal conditions:

TABLE I—MINE PRODUCTION OF COPPER IN THE UNITED STATES, 1911, 1912, 1913

| | Pounds | |
|---|---|---|
| 1911 | 1,083,856,371 | Average, 1,183,787,571 lb. |
| 1912 | 1,241,770,508 | |
| 1913 | 1,225,735,834 | |

During the war, worked to the utmost of capacity, the production was as follows:

| | | |
|---|---|---|
| 1915 | 1,423,698,160 | Average, 1,806,732,815 lb. |
| 1916 | 1,942,776,309 | |
| 1917 | 1,922,555,903 | |
| 1918 | 1,937,900,887 | |

Subsequent to the war, the output was as follows, but in 1921, for the last nine months of the year, the production was discontinued by all but a few mines:

| | | |
|---|---|---|
| 1919 | 1,209,614,818 | Average, 985,152,163 lb. |
| 1920 | 1,270,841,670 | |
| 1921 (approximately) | 475,000,000 | |

Imports of copper, mainly in ore, matte, and crude metal, averaged about 400,000,000 lb. per annum prior to the war. Since the war the importation has been as follows: 1919, 429,387,594 lb.; 1920, 485,670,691 lb.; 1921 (approximately), 347,500,000 lb.

The production of our mines, plus our imports, gives substantially our total supply. The disposition of this is shown by our deliveries of copper, foreign and domestic, which during the four years previous to 1915 and the three years subsequent to 1918 is shown in Table II:

TABLE II—DELIVERIES OF FOREIGN AND DOMESTIC COPPER

| Year | Foreign, Pounds | Domestic, Pounds | Total, Pounds |
|---|---|---|---|
| 1911 | 778,902,233 | 726,700,981 | 1,505,603,214 |
| 1912 | 766,396,452 | 825,064,841 | 1,591,461,293 |
| 1913 | 887,598,373 | 793,394,449 | 1,680,992,822 |
| 1914 | 767,682,491 | 722,761,784 | 1,490,444,275 |
| Totals | 3,200,579,549 | 3,067,922,055 | 6,268,501,604 |
| Average | | | 1,567,125,401 |
| 1919 | 366,331,137 | 1,224,503,758 | 1,590,834,895 |
| 1920 | 466,341,570 | 1,399,653,122 | 1,225,000,000 |
| 1921 | 560,000,000 | 665,000,000 | 1,225,000 |
| Totals | 1,392,672,707 | 3,289,156,880 | 4,681,829,587 |
| Average | | | 1,560,609,863 |

The range of prices, monthly averages, and the averages for the years are given in Table III:

TABLE III—PRICE RANGE AND AVERAGE COPPER PRICE

| | High, Cents | Low, Cents | Average, Cents |
|---|---|---|---|
| 1911 | 13.552 | 11.989 | 12.376 |
| 1912 | 17.508 | 14.084 | 16.341 |
| 1913 | 16.488 | 14.192 | 15.269 |
| 1914 | 14.491 | 11.739 | 13.602 |
| 1919 | 22.319 | 14.856 | 18.691 |
| 1920 | 18.918 | 13.188 | 17.456 |
| 1921 | 13.555 | 11.634 | 12.502 |

W. R. Ingalls has computed that the average price of 14.95c. per lb. received for copper during the three years 1911-1913 yielded an average gross return of about 3.85c. per lb. of copper. This would result in an aggregate of about $45,500,000 on the average annual production of those years. According to the last census about $850,000,000 of capital was invested in the copper mines of the United States, and the industry employed about 50,000 persons in the production of copper. The annual gross return of $45,500,000, estimated by Mr. Ingalls, is small in comparison with the investment of capital reported by the census. But, be things as they may, the pre-war range of prices, yielding only a moderate return to the industry as a whole, succeeded in maintaining it on an even keel. The output of the mines kept fairly in line with the market, and on the basis of supply and demand there existed a general stability, making the conditions for doing business comfortable for both producers and consumers and affording steady employment to all the workmen attached to the industry.

During the war conditions were abnormal, for reasons that I need not explain, and since the war conditions have been continuously abnormal. In the first place, producers who had been urged to strain themselves to the utmost were suddenly deprived of all governmental buying, but were not able immediately to check the extraordinary production to which they had been stimulated. In the next place, it was found that all of the Allied governments had enormous surplus stocks of copper of their own. And in the third place, scrap copper was salvaged in great quantity. The economic and financial conditions of Europe, which were reflected in the grossly depreciated rates of exchange, became so disturbed as to curtail greatly the demand for copper along with that for other raw materials. Before the war we used to export a little more than 50 per cent of the product of our copper refineries, whereas since the war we have shipped abroad only about 30 per cent. Finally, we began to experience in the latter part of 1920 the inevitable readjustment in our own economic affairs, which continued throughout 1921 and early in the latter year compelled the closing of most of our mines. Notwithstanding these adversities, which have seriously affected every industry, the markets of the world have not only absorbed all the war stocks of copper held by the several governments of Europe, but also they have taken deliveries of copper from the United States at the average rate of 1,560,609,863 lb. during the three years 1919-1921, compared with an average of 1,567,125,401 lb. during the four years 1911-1914.

This record shows the basic soundness of the copper industry. Now that it is apparent that we are again approaching the normal conditions of former times, with the accumulation of stocks being rapidly absorbed

as a consequence of the curtailment, the reopening of the mines will soon be in order, and there will be excellent prospects for selling their output.

Our American copper industry, with its vast investment of capital, providing normally 56 per cent of the world's supply, and in normal times selling about 50 per cent of its production abroad, is of course entitled to a fair margin of profit, and obviously will get it. Economic principles decree that the price must be such as will induce an adequate and continuous production. Although the price improved during 1914 and at the end of the year stood at about 14c. per lb., even that price, prevailing as it does under economic conditions that are still distorted, is materially below the pre-war average that was established by the law of supply and demand.

The demand for copper is destined to increase, perhaps to an extent beyond our present rosiest conceptions, for reasons that are quite conclusive. The great consumption for copper is in the electrical industry, in which it is the key material. In pre-war years about 54 per cent of our domestic shipments of refined copper was in the form of wire bars, which affords a rough index of electrical consumption; but not the total, for electrical work uses a good deal of copper in brass and other forms. In 1921, the percentage of domestic wire bar shipments was 67½.

Now, although the United States is the most electrified country of the world, we are still a long way from our limit of electrification. Of the 24,000,000 homes of the country, only about one-third have been wired so far. Yet electric lighting is a relatively old branch of the electrical industry. New branches are developing all the time and are growing swiftly. For example, the value of laundry-machine motors manufactured in 1912 was only $7,000,000; in 1920 it was $50,000,000. But such things, important though they be, relate only to the direct increase of comfort in living. Even more important is the use of electricity toward increasing efficiency in production and transportation. The output of the central generating stations of the country increased from 16,782,000,000 kw-hr. in 1914 to 45,678,000,000 kw.-hr. in 1920, or 173 per cent. During the same period the annual gross revenue increased from $336,980,000 to $882,750,000, or 162 per cent. The installed rating of the central generating plants increased from 7,000,000 kw. in 1914 to 13,750,000 kw. on Jan. 1, 1921, and during the same period the capital invested in the light and power industry increased from $2,706,000,000 to $4,050,000,000.

Our railways are now deficient in capacity. They have not been kept up with the increase in population. We must have more carrying capacity. But instead of providing this in the form of rails, locomotives and cars, it is going to be furnished to a large extent in the form of dynamos, with their heavy fields and armatures of copper wire, and of transmission lines of copper, which will carry not coal but its energy, and will do that at a saving of 75 per cent, according to the U. S. Geological Survey.

Exactly the same things, and for the same reasons, are going to be done in Europe, which at present is far less electrified than America, but yet has more need for it, owing to its relative poverty in coal supplies. Fortunately, there are abundant water powers in Italy, France, Switzerland, and Scandinavia, which are the countries that are poorest in coal. While I have been writing this article the International Electrical Conference, sitting in Paris, has had this subject under discussion. This meeting brought together delegates from twelve countries, including the United States and Canada. Electricity as a means of moving railway trains and turning the wheels of industry is about to come into its own, according to these delegates. The Americans surprised the European experts when they outlined the extent to which electricity is made to work for the American people. The introduction into the American home of such labor-saving devices as electrical stoves, dish-washers, laundry machines, carpet sweepers, and other household conveniences amazed many of the delegates who represented countries where as yet electricity has not been utilized in the home except for supplying light, and that only to a trifling extent.

In Great Britain the Northeastern Railway has completed plans for the electrification of 250 miles of its line, and a start will soon be made on the work, providing for the transmission of energy developed from coal in a central power plant. Besides this project, others of similar nature are under consideration, and in several instances are beginning to take concrete form.

Quickening in the demand for such purposes is already to be discerned clearly. Our wire-drawers are already reporting good business and increasing demand. Similar reports come to us from Europe. Germany in particular is using a great deal of copper, and its mills are working night and day. Germany not only has to buy and manufacture copper for the improvement of its national efficiency and for the production of wares for its export trade, but also it has to replace the copper that it stripped from its installations during the war, and is in fact now doing so. For example, the yearly requirements for locomotive fire-box plates is estimated at 90,000,000 lb. Copper is necessary for this purpose, owing to the quality of the coal used in Germany, and is now being replaced as rapidly as possible. Telephone and telegraph wires of copper that were taken down are now being put up again. In the Orient there is not only a distinct movement toward increased electrification in Japan, but, also, China is requiring a good deal of copper for coinage purposes.

Besides all of these standard uses, strenuous efforts are being made to extend the use of copper for building materials. Among other things, a form of copper shingle has been developed, which holds out good promises. This is important in itself, but perhaps the most stimulating development will be the general attention on the part of everybody interested in the copper industry to develop new uses for copper and expand its uses in the old field. Such concerted effort cannot fail to be fruitful.

Up to the advent of the war the use of copper was increasing more rapidly than the increase in population, owing to its possibilities toward elevating the scale of living of the people. The war checked this by demanding all available copper for military purposes. The industrial world is therefore in the position of going back to where it left off at the middle of 1914 and making good the requirements that there would naturally have been, but which had to be postponed.

The war produced a world-wide economic cataclysm, such as no living man ever experienced, and the after-effects were no less serious than the causes that produced them. In this general upset, resulting in a crisis of eighteen months' duration, it was inevitable that the

copper industry had to suffer, but the situation was met courageously by the producers; and it is clear now that through their bold action in closing the mines, despite the regrettable hardships that resulted for many, stockholders and employees alike, they have succeeded in bringing the copper industry rather swiftly along toward a healthy condition; and it is certain that the accumulation of surplus stocks will soon be reduced to the proportions that are normally required for a safe industrial balance wheel, and that copper mining and copper production may be resumed without any incubus. With the development of this satisfactory condition, we may rest easy in confidence that even if the readjustment of other industries be prolonged, the world's need for copper is so positive that this industry will be in a superior position.

# The Outlook for Lead

## More White Lead Used in 1921 Than in Any Other Year—Approach To Normal Consumptive Demand Expected in Lead Products—The 1922 Average Price Will Probably Exceed That of 1921

By Irwin H. Cornell
Vice-president and Sales Manager, St. Joseph Lead Co., New York

THE YEAR 1921 was probably the most unprofitable year for the lead miner since 1897. The average price for the last twenty-five years, f.o.b. cars New York, was 5c. per lb., as compared with 4.54c. for 1921. The price of lead in New York during December, 1920, was lower than in any month since October, 1915. Lead as a commodity has been liquidated. In four months, the price dropped from 8.90 to 4.50c. per lb., while the number of pounds of lead that could be produced for $1 on Jan. 1, 1921, was probably less than at any time in the history of lead mining in the United States. The cost of transportation in 1921 constituted a large part of the 4.54c. per lb. received for lead in New York. As an example, before the war it cost $100 to move a car of pig lead from East St. Louis to New York. In 1921, until Dec. 10, it cost slightly more than $330. Smelter products freight rates were advanced out of proportion to most of the other commodity rates.

The pounds of lead produced for $1 should certainly increase to a limited extent in 1922, but the average price will have to be greater than 4.50c. New York, to bring out a production of more than 400,000 tons from American mines. The price, although affected largely by the cost, must depend on, first, the tariff; second, on the consumption, and, third, on the visible and invisible stocks. The production will depend on the price.

A curve of price and production under the different tariff laws would prove without doubt that the Underwood tariff, except through extraordinary world conditions, would keep the price of lead below the point where the metal could be economically produced in this country under the present standard of wages and living conditions. To believe in better conditions in 1922, it is therefore necessary that ample protection be given the lead industry, and that the Fordney Tariff Bill be enacted into law early in 1922.

No accurate statistics concerning the consumption of lead in the United States by industries have been collected except by the United States Government agencies during the war, and these were never published. The consumption of lead must vary directly with the general business prosperity of the country, but by approaching each important industry separately, it is possible, from present conditions, to form some opinion concerning the probable demand for the metal in 1922. The most important question is whether the use of lead in the arts is decreasing or increasing. No substitute has replaced lead in any of the important industries in the United States, nor can it be argued that the present curtailment in demand is due in any way to the elimination of lead in manufactured articles.

Despite greatly disturbed business conditions, more white lead was manufactured and sold during 1921 than in any other year. There is reason to believe that the demand for lead pigments will gradually increase, although it will be remarkable if 1922 exceeds the record of 1921.

The storage-battery industry, which is second in importance to that of the paint industry, operated between 50 and 60 per cent of capacity in 1921. The outlook for 1922 is somewhat better, but the most optimistic manufacturers do not expect the business for the new year to approximate the record year of 1920. The industry as a whole should grow and probably will grow faster in the next decade than any other lead-consuming industry, and before long it is possible that in prosperous times it will consume as much lead as the paint industry.

Many lead-incased cable factories were running full time in 1921, although the probable lead consumption was about 75 per cent of normal. Lighter cables and possibly thinner sheathing were partly responsible for the reduction, and some important factories were not running full time. Business in 1922 is expected to be on about the same scale, although, as a matter of fact, the diminishing industrial loads have undoubtedly enabled the public service corporations in the big cities to get through the short days of winter on a minimum of cable, and a resumption of business might create a big demand for this grade of cable. With the growth of the telephone and the increase of underground power conductors, the cable industry should always maintain its important position with respect to the lead industry.

Lead pipe, traps, and other blue-lead products used in the building trades were in fair demand during the first half of 1921, and for the last six months of the year business was even better. The industrial demand for this class of material has been poor. For the whole year the lead presses probably turned out about 80 per cent of the normal tonnage. A large amount of building work has been planned. In certain districts the mortgage loan market has greatly improved, and if early readjustment of labor costs occurs in the large cities, a good business may be confidently expected.

The demand for sporting ammunition, in common with the demand for paint, is usually expected to be good during hard times. The last year has proved an exception to this rule. The demand from the Southern States was particularly poor, the consumption of lead by this industry being between 50 and 60 per cent of normal. There is nothing in the present situation to indicate a great increase in activity during 1922.

With the curtailment in general industrial business, the demand for bearing metals of all kinds has fallen off greatly and certainly may not be expected to be worse in 1922.

There was a small demand for sheet lead throughout the year; probably less than 30 per cent of the normal production was marketed. Added to the poor industrial situation, the low price of cotton adversely affected the demand for this commodity. With the higher price of cotton, the growers will buy fertilizers, and the chemical companies should come into the market for some sheet lead before the summer of 1922. Activity of the lead mills, however, will depend on general business conditions.

### Foil, Type and Solder Uses of Lead

The redeeming feature of the foil business in the last year has been the buying by the cigarette manufacturers. Though the demand for foil for other purposes fell off greatly, the entire industry operated at from 60 to 75 per cent of capacity. This industry in a normal year is estimated to consume about 25,000 tons of lead. The demand for foil is affected by the price, and with the present low cost of lead the industry should experience a decided improvement. Should the custom of wrapping chewing gum in foil again be adopted by the prominent makers, the outlook would be bright. The consumption of type metals runs about the same from year to year. The demand for solder, caulking lead, rubber, glass and oil oxides and counterweights for locomotive driving wheels has been small owing to the general business depression. Though each of the above-mentioned uses consumes a relatively small amount of lead, in the aggregate at least 50,000 tons in normal times is used for these purposes.

### Visible and Invisible Stocks

The visible stocks of lead at no time during the last year became unwieldy. On the other hand, they are at this time decidedly unbalanced. The stocks of desilverized lead today are small, probably smaller than the average stocks before the war. Missouri lead, on the other hand, is held in fairly large quantities. The activity in white lead, which has saved the lead-mining industry from an almost complete shutdown, has placed a premium on lead of a corroding quality.

In August, the freight rates from the Rocky Mountain states to North Atlantic ports were greatly reduced to meet the rail and water competition via the Panama Canal. There was no corresponding reduction in all-rail rates to intermediate points from the West or from the Mississippi Valley to Boston, New York, Philadelphia, or Baltimore. The large imports through the ports of New York and Philadelphia that began to arrive in April, and the August freight reduction from Rocky Mountain points to the seaboard, had the effect of drawing the St. Louis and New York markets close together, and thus denying to Missouri lead its usual outlet in the East. As before stated, the sheet lead and battery industries, both large users of Missouri lead, were far below normal. Manufacturers of foil, cable, caulking lead, lead pipe, babbitt, and other lead alloys situated in the East, who in the past had used some Missouri lead, used desilverized almost exclusively. The Spanish lead brought to Atlantic ports was sold largely to Eastern manufacturers. The combination of these circumstances brought about the conditions responsible for the accumulation of stocks of Missouri lead and the comparative scarcity of desilverized lead. Invisible stocks are low, as manufacturers in general have been following a hand-to-mouth policy of purchasing.

### Secondary Lead

The production of secondary lead has increased steadily from year to year. In 1912, the U. S. Geological Survey estimated a production of 67,168 tons. In 1919 it had reached the large amount of 125,000 tons, and in 1921 was probably almost as large. To this should be added the tonnage of shrapnel balls imported under the classification of type metal and paying a 15 per cent ad valorem duty. About 16,000 tons of this material was imported in 1921.

Stocks of pig lead on Jan. 1, 1922, including metal in the hands of consumers as well as in those of producers, are probably little if any larger than one year ago. Production in 1921 was about 400,000 tons, or 75,000 tons less than in 1920. The production in 1922 will probably be about the same if the price does not average over 4.50c. per lb., New York. Imports of lead and type metal less the exports for the first ten months of 1921 were around 65,000 tons. Imports in 1922 will depend on the tariff.

With the indicated betterment in business conditions in the majority of the lead-consuming industries, and with the prospect of a falling off in imports, it is assumed that a domestic production equal to the production in 1920, about 475,000 tons, will be required. Though the price during the last two months of 1921 was undoubtedly held down by the stocks in producers' hands, heavy buying during the final weeks of the year had a material effect on this situation, and it is reasonable to assume that the average price for 1922 will have to exceed that of 1921 to bring out the lead which it is estimated will be needed.

PRODUCTION OF LEAD (REFINERY STATISTICS) 1916-1921 (*a*)

In Tons of 2,000 Lb.

| Domestic | 1916 | 1917 | 1918 | 1919 | 1920 | 1921 |
|---|---|---|---|---|---|---|
| Desilverized | 330,189 | 319,015 | 284,733 | 226,085 | 236,912 | 202,649 |
| Antimonial | 22,819 | 16,265 | 18,658 | 14,864 | 8,992 | 5,419 |
| S. E. Missouri | 206,105 | 205,861 | 189,207 | 158,182 | 206,836 | 142,804 |
| S. W. Missouri | 33,128 | 40,575 | 63,635 | 55,790 | 29,004 | 56,155 |
| Totals | 592,241 | 581,716 | 556,233 | 454,921 | 471,744 | 406,896 |
| Foreign | | | | | | |
| Desilverized | 17,832 | 50,962 | 98,596 | 61,380 | 51,700 | 47,697 |
| Antimonial | 3,304 | 2,991 | 2,083 | 1,547 | 2,197 | 2,361 |
| Totals | 21,136 | 53,953 | 100,679 | 62,927 | 53,897 | 50,058 |
| Grand totals | 613,377 | 635,669 | 656,912 | 517,848 | 525,641 | 456,954 |

(*a*) These figures include the lead derived from scrap and junk by primary smelters.

MONTHLY AVERAGE PRICE OF LEAD

| Month | New York | | | St. Louis | | | London | | |
|---|---|---|---|---|---|---|---|---|---|
| | 1919 | 1920 | 1921 | 1919 | 1920 | 1921 | 1919 | 1920 | 1921 |
| January | 5.432 | 8.561 | 4.821 | 5.316 | 8.300 | 4.747 | 37.227 | 47.095 | 23.387 |
| February | 5.057 | 8.814 | 4.373 | 4.784 | 8.601 | 4.228 | 28.675 | 50.256 | 20.650 |
| March | 5.226 | 9.145 | 4.084 | 4.992 | 8.894 | 4.000 | 27.952 | 46.054 | 18.911 |
| April | 4.982 | 8.902 | 4.356 | 4.722 | 8.618 | 4.272 | 24.888 | 39.225 | 20.589 |
| May | 5.018 | 8.576 | 4.952 | 4.773 | 8.352 | 4.784 | 25.852 | 38.488 | 23.399 |
| June | 5.340 | 8.323 | 4.485 | 5.070 | 8.169 | 4.293 | 22.544 | 34.330 | 22.563 |
| July | 5.626 | 8.338 | 4.410 | 5.408 | 8.283 | 4.260 | 23.457 | 34.960 | 23.399 |
| August | 5.798 | 8.687 | 4.382 | 5.583 | 8.725 | 4.217 | 24.750 | 36.304 | 23.489 |
| September | 6.108 | 8.177 | 4.600 | 5.853 | 8.160 | 4.392 | 25.330 | 35.452 | 23.148 |
| October | 6.487 | 7.070 | 4.690 | 6.249 | 7.018 | 4.439 | 28.473 | 35.238 | 23.679 |
| November | 6.808 | 6.159 | 4.683 | 6.649 | 6.127 | 4.356 | 34.731 | 32.489 | 24.483 |
| December | 7.231 | 4.727 | 4.700 | 6.955 | 4.717 | 4.369 | 41.202 | 24.089 | 25.322 |
| Year | 5.759 | 7.957 | 4.545 | 5.530 | 7.830 | 4.363 | 28.590 | 37.832 | 22.752 |

New York and St. Louis, cents per pound. London, pounds sterling per long to n

# The Outlook for Zinc

## Constructive Upward Movement Beginning—Production Outside of the United States Declines—A Return to Normal Conditions Foreshadowed —World's Supply of Brass Scrap Now Exhausted—Foreign Situation

BY A ZINC SPECIALIST

A SENSIBLE PESSIMIST would be likely to feel encouragement in the present prospect for zinc, because he would find it difficult to anticipate during 1922 a duplication of all the unhappy factors, economic and political, which affected affairs in general and the zinc industry in particular during 1921.

A sensible optimist would be likely to feel greater encouragement, because he does not find it difficult to note already not only the gradual disappearance of many of the adverse factors but also the inevitable beginnings of a new constructive era: cheaper money, consequent upon increased frugality, and, for the time being, slow business and reduced calls for credit; rising security prices, with their facilitation of increased financing of under-equipped railroads and public utilities whose lack of purchasing power has been no mean factor in the past depression; cheaper prices for such manufactured articles and foodstuffs as enter largely into the average man's "cost of living"; production systematically curtailed for a long enough time to start an upward movement in price level of most of the abnormally depressed commodities; small inventories; and in general, a growing uniformity in the levels of liquidation. All these factors are symtomatic of the beginnings of a constructive upward movement and are pertinent to any discussion of zinc, even though this industry has been additionally affected in the immediate past by conditions peculiarly its own.

For a thorough understanding of the precarious situation of the zinc industry in 1921 and its prospects for 1922, consideration must be given to the changed position of the United States in the world's market. Although zinc was a metal notably stimulated by the demands of the World War, it is significant that the world's production of zinc has never exceeded the total for 1913, when 1,113,860 tons was produced. Of this total, roughly 70 per cent was produced outside of our country. From that time on, European production progressively declined, and though complete figures for 1921 are not available they will show a marked decrease from 1920, when production outside of the United States totaled only 315,000 tons, or less than 50 per cent of its 1913 production. In other words, the entire increase incident to war needs was supplied by the United States, where production rose from 353,000 tons in 1913 to 682,000 in 1917, declining only to 435,000 tons in 1920, and in the pit of the depression in the winter of 1920 going on at the rate of 360,000 tons per annum, or above the highest pre-war average, and this at a time when not only had we many months previously stopped exporting zinc but were actually importing large tonnages of European metal, a state of things which continued into April and May of last year, when we imported nearly 7,000 tons of foreign metal.

The condition of the zinc industry in this country in 1921 was a logical aftermath of these facts. And the facts were an equally logical outcome of the peculiar structure of our zinc industry, as developed by the war, and its direction by too many, and unfortunately too inexperienced, hands. Many factors facilitated the tremendous and temporarily profitable growth of the United States zinc industry during the World War—cheap fuel, particularly gas, contiguous to the largest zinc-mining district; relatively cheap and simple plant construction; demand for zinc at continuously rising prices, which permitted the mining of much low-grade ore, including the reworking of tailings and nearly exhausted properties in the Joplin district, and which, in conjunction with the recent development of oil flotation, electro-magnetic and electro-static concentration processes, released for use large quantities of hitherto useless ore.

With the removal of war stimulus to production, the industry, highly decentralized and with no one interest controlling more than 15 per cent of the total productive capacity and all eager to retain their previous position in it, seemed carried on by the resulting momentum. Too few of its operators seemed to realize its disproportionate size to the normal demands of this country, its only natural market, and they were encouraged in their failure so to realize by the abortive industrial boom which began in 1919 and ended in disaster in the fall of 1920. Belated realization came in 1921. Production, which on Jan. 1, 1921, was at the rate of 342,000 tons per annum, or 28,500 per month, dropped sharply on April 1 to 15,500 tons per month, at approximately which rate operations were being conducted at the end of the year.

In considering the outlook for zinc, it must be remembered that no basic industry can remain for more than a limited period on a non-paying basis. Such a period existed throughout 1920 and 1921 and represented the inevitable adjustment due an industry when the causes for its sudden growth beyond its normal sphere in the country's industrial economy disappear temporarily. The United States is self-contained with respect to its zinc requirements and supplies, and so, taken as a unit, is the rest of the world. We are now producing at the rate of less than 200,000 tons a year, as against an average production, all used domestically, of over 300,000 tons for the six years preceding the war—all of them quiet, unspectacular years in the business world, and so reflecting genuinely normal production needs in all our basic industries. Merely to return to the consumptive requirements of these years—and we are definitely on the way by all known signs—would be a great improvement for the zinc industry. It is impossible not to anticipate a greater improvement when one realizes that the factors of standard of living, population increase and financial strength which dominate the normal growth of every basic commodity have not been impaired to any real extent.

Granted that there is before us a return to relatively normal conditions, with gradually improving business, it is logical to examine some of the major factors specific to the zinc industry which affect supply and demand. The brass industry has for some time been

practically out of the market for zinc, finding ample supplies of scrap. It has been estimated that the zinc contents of the world's supply of brass scrap totaled nearly 200,000 tons on Jan. 1, 1919. The total had decreased to less than 100,000 tons by Jan. 1, 1921, and though exact figures for the present status are lacking, the total today is very small. There are no available stocks of real moment in the country, three-quarters of the Government's scrap having been sold by the end of 1920 and the remainder in 1921. Europe has turned from a seller to a buyer, and the sole remaining stocks, in England, are being rapidly depleted by demands from the home industries, from this country and from Europe. Stocks of 60-40 material have been exhausted and only a little 70-30 brass scrap remains.

So far as the supplies of ore are concerned, the condition is a healthy one from a market standpoint. With the exception of the electrolytic production and retort production of high-grade metal in the East, zinc smelters will undoubtedly be restricted to drawing upon the Mid-Continental ore fields, as none of the major Western mines are likely to supply ore until the price of zinc has advanced somewhat over a cent a pound above the present level. For that matter, higher ore prices are likely in the Joplin district if even the present low production is to be maintained. During the last two years of depression in the zinc industry, with ore selling at from $53 to $35 per ton during 1920, averaging $46, and from $28 to $20 during 1921, averaging, so far as figures show at this time, about $24, as against an average of $43 per ton for the five-year pre-war period, it is believed in many directions that production has been maintained only at the expense of mining the richest ore, that operators are now getting into poorer ground, and that ensuing operations will be carried on with diminishing margins on the basis of the present market. Moreover, though smelting costs have been steadily reduced, plant operations are still unprofitable, and so an increase in the supply of both ore and metal can be logically assumed to depend upon higher prices.

The present foreign situation and the outlook abroad warrant a high degree of optimism, and a study of conditions will do much to relieve us from the fear, concretely expressed in our proposed zinc tariff, of an influx of foreign metal to the detriment of the domestic industry. In the first place, curtailment of production abroad was far more closely and quickly proportioned to curtailed demand, and in the early part of 1920 stocks of zinc were relatively lower there than here. For example, in Great Britain, in April, the first date in 1920 for which figures became available, stocks stood at 29,000 tons, as against 32,000 for this country; a year later they stood at 19,000 tons in Great Britain and 81,000 tons here. On the Continent production for 1921 steadily declined. Belgium started the year at the rate of 9,000 tons per month and finished at the rate of 5,000 tons per month; the remainder of the Continent began the year producing at the rate of 10,000 tons per month, of which 6,000 was produced by Germany, and steadily declined.

The result was that when an estimate of stocks was made near the end of 1920, the stock of zinc in the entire world outside of the United States was less than stocks here, despite our own healthy reduction. In the meantime, improved business abroad had set in. It was reported, for example, that in September alone, the first month of real recovery for Great Britain, nearly 60,000 tons of galvanized sheets were booked there for export, later months showing continued improvement. Still, production abroad has not increased, and it therefore comes within the range of possibility that exports of zinc from this country may take place to meet foreign demand—a striking contrast to the apprehension of last spring of our domestic market being swamped with cheap foreign metal.

Though some increase in production abroad is to be expected should conditions there continue to improve, several reasons suggest that it is likely to increase but slowly. More than half of Europe's pre-war production was derived from ore imported into the smelting countries, particularly Belgium, France, and Germany, from Australia, Indo-China, Africa, Italy, Spain, Greece, and Russia. An essential to this situation was cheap ocean freights, and, though freight rates have declined, they are still far too high to permit an early profitable return to the old basis of operations. Smelting costs are also very high, owing particularly to fuel costs.

Furthermore, there are changed conditions in the mining situation of Australia, the largest source of

AMERICAN PRODUCTION OF ZINC 1916–1921

In Tons of 2,000 Lb. By Ore Smelters Only

| | 1916 | 1917 | 1918 | 1919 | 1920 | 1921 |
|---|---|---|---|---|---|---|
| Arkansas | 7,634 | 25,701 | 26,750 | 31,396 | 29,966 | 14,917 |
| Colorado | 8,908 | 7,735 | 3,897 | 2,779 | 1,682 | 1,200 |
| Illinois | 181,495 | 176,071 | 141,808 | 118,631 | 109,483 | 52,183 |
| Missouri-Kansas | 154,396 | 86,505 | 31,834 | 43,347 | 25,131 | 31,784 |
| Oklahoma | 169,064 | 204,587 | 143,371 | 119,454 | 97,690 | 36,644 |
| Electrolytic | 10,963 | 27,245 | 38,885 | 25,962 | 57,441 | 11,553 |
| East and others | 147,555 | 154,567 | 138,805 | 130,115 | 158,379 | 67,333 |
| Totals | 680,018 | 682,411 | 525,350 | 471,684 | 479,772 | 215,614 |

Production for 1920 and 1921 through the courtesy of the American Zinc Institute.

ZINC PRODUCTION, STOCKS AND SHIPMENTS

Compiled by American Zinc Institute

In Tons

| 1921 | Zinc on Hand First of Month | Produced During Month | Total for Month | Shipped During Month | Zinc on Hand End of Month | Increase | Decrease |
|---|---|---|---|---|---|---|---|
| January | 71,058 | 25,916 | 96,974 | 21,021 | 75,953 | 4,895 | ..... |
| February | 75,953 | 17,769 | 93,722 | 15,702 | 78,020 | 2,067 | ..... |
| March | 78,020 | 15,741 | 93,761 | 12,771 | 80,990 | 2,970 | ..... |
| April | 80,990 | 16,550 | 97,540 | 17,959 | 79,581 | ..... | 1,409 |
| May | 79,581 | 18,026 | 97,607 | 13,886 | 83,721 | 4,140 | ..... |
| June | 83,721 | 19,443 | 103,164 | 13,275 | 89,889 | 6,168 | ..—. |
| July | 89,889 | 15,495 | 105,384 | 12,976 | 92,408 | 2,519 | ..... |
| August | 92,408 | 14,621 | 107,029 | 20,480 | 86,549 | ..... | 5,859 |
| September | 86,549 | 14,367 | 100,916 | 19,781 | 81,135 | ..... | 5,414 |
| October | 81,135 | 14,538 | 95,673 | 24,849 | 70,824 | ..... | 10,311 |
| November | 70,824 | 21,135 | 91,959 | 24,910 | 67,049 | ..... | 3,775 |
| December | 67,049 | 22,013 | 89,062 | 22,454 | 66,608 | ..... | 441 |
| Tons | ..... | 215,614 | ..... | 220,064 | ..... | ..... | ..... |

RETORTS

| 1921 | Capacity | Available | Average Number Operating During Month | Average Number Operating End of Month | Increase or Decrease |
|---|---|---|---|---|---|
| January | 157,676 | 139,632 | ..... | 44,781 | D. 13,848 |
| February | 158,176 | 140,132 | 41,893 | 37,782 | D. 6,999 |
| March | 158,178 | 140,132 | 34,386 | 35,297 | D. 2,485 |
| April | 158,176 | 140,132 | 38,732 | 39,673 | I. 4,376 |
| May | 155,256 | 136,972 | 40,607 | 40,043 | I. 370 |
| June | 150,792 | 133,964 | 37,907 | 35,789 | D. 4,254 |
| July | 153,736 | 135,792 | 32,543 | 30,349 | D. 5,440 |
| August | 155,656 | 137,712 | 29,518 | 29,576 | D. 773 |
| September | 155,656 | 137,712 | 29,110 | 29,429 | D. 147 |
| October | 155,656 | 137,712 | 26,859 | 27,949 | D. 1,480 |
| November | 155,656 | 137,712 | 46,567 | 46,444 | I. 18,495 |
| December | 155,656 | 137,712 | 41,080 | 42,369 | D. 4,075 |

Note: Stored for account of customers, Dec. 31, 1,916 tons.

MONTHLY AVERAGE PRICE OF ZINC

| Month | St. Louis 1918 | St. Louis 1919 | St. Louis 1920 | St. Louis 1921 | London 1918 | London 1919 | London 1920 | London 1921 |
|---|---|---|---|---|---|---|---|---|
| January | 7.661 | 6.922 | 9.133 | 5.413 | 54.000 | 56.045 | 58.643 | 25.262 |
| February | 7.639 | 6.273 | 8.708 | 4.928 | 54.000 | 46.150 | 61.338 | 24.850 |
| March | 7.286 | 6.150 | 8.531 | 4.737 | 54.000 | 38.500 | 53.467 | 25.077 |
| April | 6.715 | 6.114 | 8.184 | 4.747 | 54.000 | 36.188 | 47.388 | 25.530 |
| May | 7.114 | 6.079 | 7.588 | 4.848 | 54.000 | 35.477 | 45.088 | 26.923 |
| June | 7.791 | 6.551 | 7.465 | 4.421 | 54.000 | 36.763 | 41.193 | 26.750 |
| July | 8.338 | 7.523 | 7.720 | 4.239 | 54.000 | 41.815 | 41.886 | 26.262 |
| August | 8.635 | 7.439 | 7.835 | 4.186 | 54.000 | 39.338 | 41.220 | 25.068 |
| September | 9.092 | 7.160 | 7.661 | 4.235 | 54.000 | 40.935 | 39.690 | 25.256 |
| October | 8.451 | 7.473 | 7.150 | 4.605 | 54.000 | 43.630 | 39.756 | 26.315 |
| November | 8.141 | 7.827 | 6.247 | 4.665 | 54.100 | 46.588 | 35.028 | 25.949 |
| December | 7.813 | 8.350 | 5.824 | 4.837 | 56.050 | 53.101 | 27.762 | 26.900 |
| Year | 7.890 | 6.988 | 7.671 | 4.655 | 54.180 | 42.879 | 44.372 | 25.845 |

St. Louis, cents pe rpound. London, pounds sterling per long ton.

pre-war European ore supply. Its great mining center, the Broken Hill lode, has been operated since 1884. Early operations there had lead ores as their object, and immense dumps of zinc-bearing ores and zinc tailings were accumulated as a result of lead-ore mining and concentration. These were estimated about twenty years later to total nearly 6,000,000 tons, running slightly less than 20 per cent zinc. As demand developed for sulphide ores, the dumps became important sources of supply, particularly with the application of the oil flotation method of concentration. Today, however, the dumps are approaching exhaustion, and to again approach Australia's pre-war production fresh mining operations are necessary, entailing more expense and resulting in less remunerative ore, as most of the ore-bodies now being exploited and available for exploitation are deep-seated. In fact, it is estimated that a decrease rather than an increase in production is likely for Australia.

There are other districts where increased production may occur, particularly in Burma, from the Bawdwin mines. There are also interesting possibilities in the electrolytic zinc development in Tasmania, but these sources of future increase all entail expensive equipment and large-tonnage operations for profitable working, and so will not make themselves felt until world business conditions show a far greater improvement than exists today.

# The Outlook for Tin

## Uneventful Market in 1921—Pegged Prices in Straits Necessitated In Local Emergency—Uncertainties of Tin Statistics—Visible Supplies And Eastern Stocks Preclude Domination of Speculative Groups

By J. H. Lang
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THE TIN MARKET of 1921, though characterized by the usual wide variations in price, was tame and uneventful compared to the wild and exciting times of 1920. The price range in London was only £62, from £210 to £148, and in New York from 38¾c. to 25½c. In 1920, the price range in London was from £420 to £195, a total of £225, and in New York from 65c. to 32½c. It was only in January, 1921, that the extreme fluctuations of 1920 persisted, the market in that month declining from its high for the year (£210) to £164 on Jan. 25. Thereafter there was a further decline, until the low of the year was reached on March 9 at £148 London and 27c. New York. There was a reaction from this low point to £184 on May 23, and a subsequent decline culminating Aug. 25 at £150 London and 25½c. New York. After this there was a slow and gradual recovery to £174 London and 33¾c. New York, on Dec. 16. The close was £170½ and 33½c. Though March 9 was the lowest in London, Aug. 25 was the lowest in New York, owing to lower exchange in August. Of the subsequent rise from 25½c. to 33¾c. about 50 per cent was due to the rise in the tin market itself and 50 per cent to the advance in exchange.

This in brief was the course of the market during 1921. As to the causes thereof, the year opened with a "pegged" price in the Straits equivalent to about £229 f.o.b. Singapore. Though the economic fallacy of the pegging policy was universally recognized, the general impression was that it would be maintained and carried to a successful conclusion as in 1919. Confidence in this belief was shaken by a reduction early in February, and finally at the end of February the Straits government withdrew altogether as buyer, whereupon the market declined sharply to its low point in March.

In justice to the government of the Federated Malay States, it should be said that nobody realized better the unsoundness of the policy pursued. It was adopted as a temporary expedient under pressure of social and political conditions peculiar to the Straits. The mines are worked almost exclusively by imported coolie labor, which would begin to starve and riot if without work for even a few weeks. In a country so sparsely settled and inadequately policed this constituted a menace necessitating immediate remedial measures. The mines would have closed just as the copper mines closed in this country had not the government stepped in and bought the tin. The alternatives were to support the coolies in idleness or to deport them. The proper remedy would have been to close the mines, but in that event the whole industry would have been ruined and could not have been established again in a generation.

The government took practically the only available steps for meeting the emergency, but it bought as little as possible, reduced the price as soon as it could, and abandoned the scheme at the earliest practicable moment. Even so, it had accumulated about 10,000 tons, against which $10,000,000 in bonds were issued, and the matter stands in that position today. How to sell the tin and liquidate the bonds is one of the most pressing problems engaging the attention of government officials there at the present moment. The carrying charges are a heavy burden on the revenues of the country, the prosperity of which has suffered severely from drastic declines in other commodities as well as in tin, particularly in rubber. Aid had to be extended to that industry also.

A similar policy was adopted by the government of the Dutch East Indies, which likewise accumulated tin and held it off the market, the general estimate being that there are now between 5,000 and 6,000 tons in Java awaiting higher prices. To the end of September, Banca production was 1,000 tons more than in 1920. For the year, shipments were 3,000 tons less. Unfavorable Chinese exchanges seriously interfered with exports from that country. It is reported that between 3,000 and 4,000 tons of tin is now lying in Hongkong. We thus have 18,000 or 20,000 tons, exclusive of Bolivia, in "invisible" supplies—i.e., not appearing in statistics.

Aside from this matter of invisible stocks, which can never be dealt with satisfactorily in statistics, the latter as at present compiled are exceedingly unreliable, because they include at best only two-thirds to three-

quarters of the output, presenting an incomplete and often misleading picture of the situation. A case in point is cited later. There is urgent need for statistics which will deal with the entire primary production and consumption of tin in a clear and concise manner. A proposition to that end has been made by the New York Metal Exchange to the London Metal Exchange, and it is hoped to work out the problem more efficiently than is being done at present.

### Uncertainty of Tin Statistics

Statistically also, the position of tin has deteriorated, the visible supply having increased 5,600 tons from 18,439 tons at the beginning of 1921 to 24,060 tons at the end, or a total stock, visible and invisible, of more than 40,000 tons, which is unprecedented. These increased stocks are due entirely to the great falling off in American deliveries, caused by large supplies carried over from 1920 and the slump in business. The average monthly deliveries, January to August inclusive, were only about 1,500 tons, and for the whole year the total was fully 50 per cent less than that of 1920. Europe, despite its troubles, has done measurably well, absorbing practically the same quantity as in the preceding five years, though 10,000 tons less than its average annual takings for five years before the war.

The improvement in deliveries to the United States during the last five months of 1921 was due partly to better business, partly to depletion of stocks, but more to the peculiar conditions surrounding the domestic output of tin. This latter is almost wholly dependent upon Bolivian ores. The situation in that country is obscure, but on account of low prices, labor troubles, unfavorable legislation, voluntary restriction, or other causes, the Bolivian shipments of 1921 will amount to only about 15,000 tons, instead of approximately 30,000 tons as usual. The situation must come to an end and more normal conditions be restored before long. Even at the low prices of the year, depreciated Bolivian exchange enabled sellers to realize in the currency of that country prices almost equivalent to those formerly obtained with tin at £200. That the mines can produce profitably at the return they are now receiving seems beyond question.

The reduction of the Bolivian output has curtailed the production of domestic tin and compelled consumers to use correspondingly larger quantities of imported tin. Imported tin is included in statistics. Domestic tin is not. As a consequence, deliveries are always larger than shown in statistics. When statistics showed 1,500 tons monthly deliveries, the deliveries were as a matter of fact considerably larger. Conversely, the published figures now benefit through the smaller quantity of domestic available and the additional imports of foreign tin required to make up the deficiency. Hence, we are not now on a basis so near normal as appears, any more than we were during the first seven months of the year on a basis so far below normal.

Immediately the domestic smelters are again able to operate fully and displace imported metal with the home-made article, the relatively favorable showing of the past few months will be impaired unless and until consumption so improves as to absorb not only the increased domestic output but the larger quantity of foreign tin now imported to take its place. The Government's conservation policy initiated during the war has been exceptionally succesful in the case of tin, the amount recovered from old material and used again rising from 12,000 tons in 1914 to 24,000 tons in 1920. This tin is not, of course, included, and cannot be included, in statistics.

### Future in the Tin Market

The large supplies now visible, plus the large Eastern stocks overhanging the market, make it impossible for speculative groups to dominate and control the situation as they have done almost continually for a generation or more. What tin is worth without such speculative control and manipulation we do not know, but we do know that the Dutch government's cost of production before the war was not over £50 per ton, and that within a generation tin has sold as low as £56 in London and 12⅝c. New York. We also know that the cycle of post-war liquidation and deflation resulting in cheaper costs of production and lower prices, which the world must have before prosperity can be restored, is not yet completed.

Eventually, and without speculative control and manipulation, tin should sell at the cost of producing the quantity required, plus a fair profit, and no more. Absorption of stocks is likely to be slow. Decreased American deliveries account for increased stocks, but increased American deliveries will meet increased supplies, leaving stocks intact. Increased supplies do not necessitate increased production, but only that the tin produced shall be marketed. With the same production in 1922 as in 1921, 20,000 tons more will be shipped (unless stocks are further accumulated at the source of supply).

With remunerative prices, production should return to normal, which implies an increase of 20,000 tons in 1922 over 1921, or a total of 40,000 tons more available during the next twelve months than in the twelve months just past, and this without drawing on stocks, either visible or invisible. If the invisible is sold and shipped, we shall have 60,000 tons more, or just about double the quantity available in 1921—all predicated, of course, on high prices. Low prices alone can prevent it. What are high and low prices for tin? Everybody is agreed that £400 was high; £200 was the three-year average prior to the war (1911-12-13). The market lately has shown a disposition to regard £150 as low. Whether or not this decision will stand, remains to be seen. Decreased production has either been voluntary or enforced by abnormal conditions. The latter are righting themselves, and the former will be abandoned.

Tin is one of the most highly speculative commodities in the world. The great volume of speculation compressed within the narrow limits of the tin market often results in prices out of all proportion to value. Nor are all the speculators confined to the gambling fraternity. Many dealers and consumers who would possibly resent the charge are nevertheless great speculators in tin, as was shown in 1918 and again in 1920, with most disastrous results in both instances.

Subsequent events proved that at the time of the Armistice in 1918 we had a year's supply of tin hidden away, and there is no doubt that we were heavily overbought at the end of 1920. If we insist on repeating these costly experiences, doubtless both the surplus stocks and the increased production can be unloaded on us at high prices. Momentarily the market is strong, and predictions of further advances are freely made. Perhaps these predictions will be realized, but it should

be borne in mind that America makes and unmakes the tin market. The steam gage is in London, but the boiler is here. Supplies are ample. If we pursue a sane and conservative buying policy, we should have no fear of a runaway market. The situation on its merits does not warrant high prices.

### Need of an Active New York Metal Exchange

When Europe speculates she does so on the metal exchange. She does not take delivery except of what she needs, but trades in contracts, as is done here in wheat, corn, and cotton. Hence the uniformity of her deliveries in good times and bad. America, on the other hand, buys real tin, takes delivery of it, pays for it, and stores it away outside of the visible, thus distorting statistics, and giving an exaggerated idea of consumption, and adding fuel to the speculative flames, until the inevitable crash comes, catching us with large stocks on hand, against which we have no hedges and for which there is no market. All of which is crude, wasteful, and unscientific. We stack the cards against ourselves. There is no less speculation in Europe than in America, but until we learn to use our metal exchange as Europe uses hers, we will be at a disadvantage. An active metal exchange in New York would broaden the market and be of great benefit to all the metal trades, both at home and abroad.

The following tables illustrate the price fluctuations, visible supply and stocks and deliveries in recent years:

MONTHLY AVERAGE PRICES OF TIN

| | New York | | | | London | |
|---|---|---|---|---|---|---|
| | 99% | | Straits | | | |
| Month | 1920 | 1921 | 1920 | 1921 | 1920 | '921 |
| January | 61.596 | 31.470 | (a) | 36.000 | 376.512 | 199.464 |
| February | 58.466 | 28.534 | 59.932 | 32.142 | 395.750 | 166.250 |
| March | 61.037 | 27.296 | 61.926 | 28.806 | 369.489 | 156.024 |
| April | 61.120 | 28.990 | 62.115 | 30.404 | 345.450 | 163.905 |
| May | 53.230 | 31.431 | 55.100 | 32.500 | 294.813 | 177.411 |
| June | 46.125 | 28.514 | 48.327 | 29.423 | 250.614 | 167.506 |
| July | 45.798 | 26.755 | 49.154 | 27.655 | 261.886 | 164.530 |
| August | 43.856 | 25.662 | 47.620 | 26.301 | 274.048 | 155.318 |
| September | 41.940 | 26.280 | 44.465 | 26.680 | 270.120 | 156.750 |
| October | 39.310 | 27.278 | 40.555 | 27.655 | 258.190 | 156.380 |
| November | 35.667 | 28.592 | 36.854 | 28.935 | 241.080 | 158.898 |
| December | 31.135 | 32.106 | 34.058 | 32.486 | 212.440 | 169.738 |
| Year | 48.273 | 28.576 | 49.101 | 29.916 | 295.866 | 165.265 |

(a) No average computed.
New York in cents per pound; London in pounds sterling per long ton.

CLOSING PRICE OF SPOT STRAITS TIN AND OF STERLING EXCHANGE—END OF EACH MONTH OF 1921

| | Spot Straits Tin, London, | Currency Equivalent, New York, | Spot Straits Tin, New York, | Spot Sterling Exchange, New York |
|---|---|---|---|---|
| | Pounds | Cents | Cents | |
| January | 187–10 | 32.23 | 33.75 | $3.85 |
| February | 176–10 | 30.42 | 30 | 3.86 |
| March | 166–10 | 29.14 | 29 | 3.93 |
| April | 178–10 | 31.48 | 32 | 3.95 |
| May | 178 | 30.74 | 31.50 | 3.87 |
| June | 167–10 | 27.89 | 28.875 | 3.73 |
| July | 160–5 | 25.54 | 26.50 | 3.57 |
| August | 157–15 | 26.26 | 27. | 3.73 |
| September | 157 | 26.08 | 26.625 | 3.72 |
| October | 157 | 27.60 | 28.25 | 3.94 |
| November | 162–15 | 29.05 | 29.75 | 4.00 |
| December | 171–15 | 32.23 | 33.125 | 4.21 |

VISIBLE SUPPLY AND LONDON PRICES FOR SPOT STANDARD TIN AT THE END OF 1912-1921

Pounds Sterling per Ton of 2,240 Pounds.

| | Tons | London Price |
|---|---|---|
| 1921 | 24,060 | £170–10–0 |
| 1920 | 18,439 | £206– 0–0 |
| 1919 | 21,320 | £341– 5–0 |
| 1918 | 20,945 | £296– 0–0 |
| 1917 | 19,057 | £193– 0–0 |
| 1916 | 17,561 | £179– 0–0 |
| 1915 | 16,108 | £170– 0–0 |
| 1914 | 15,858 | £148– 0–0 |
| 1913 | 14,571 | £170– 0–0 |
| 1912 | 11,668 | £229–10–0 |

SUPPLIES, DELIVERIES AND STOCKS OF TIN AT THE BEGINNING AND END OF EACH YEAR 1913-1921 IN TONS OF 2,240 POUNDS.

| | 1921 | 1920 | 1919 | 1913 |
|---|---|---|---|---|
| Visible supply Jan. 1 | 18,439 | 21,320 | 7,787 | 11,668 |
| Supply | | | | |
| Straits | 36,107 | 45,431 | 51,045 | 62,467 |
| Australian | 1,175 | 3,000 | 2,600 | 3,300 |
| Banca and Billiton | 11,874 | 14,762 | 13,801 | 17,142 |
| Standard | 10,537 | 14,336 | 8,536 | ..... |
| Total supplies | 59,693 | 77,529 | 75,982 | 82,909 |
| Total available | 78,132 | 98,849 | 83,769 | 94,577 |
| Deliveries | | | | |
| Europe | 28,394 | 27,191 | 29,445 | 40,540 |
| United States | 25,678 | 53,219 | 33,004 | 39,466 |
| Total deliveries | 54,072 | 80,410 | 62,449 | 80,006 |
| Visible supply Dec. 31 | 24,060 | 18,439 | 21,320 | 14,571 |

# The Outlook in Iron

## Living on Stocks in 1921 Has Swept the Country Bare of Steel—Railroad and Building Main Dependencies of the Industry—Increase in Iron and Steel Production in 1922 Expected

By Alvin I. Findley
Editor, *The Iron Age*, New York

REVIEWERS of 1921 and prophets of 1922—economists, financial writers, and leaders in banking and business—have made hopeful expressions concerning the new year. This is generally the case with business forecasts. At the opening of 1921 very few who wrote of the future seemed to look for anything like the severe industrial depression that developed. Predictions concerning the steel trade were no exception. There were even some iron and steel men who had an idea that 1921 would bring some rebound from the declining prices of the late months of 1920. Nothing of that sort happened, with the exception of a few jog-like advances that were succeeded by fresh declines. The price lines of the year trend uninterruptedly downward.

Sentiment in the steel trade today agrees generally with the views of the prophets who have already written about 1922. But steel manufacturers are not much given to definite prediction. Those of them who have been in the business for two or three decades have seen so much of the alternation of the lean and fat, and of the rapidity with which one condition can succeed the other, that their most dependable formula is that it is the unexpected that happens.

### Living on Stocks

One reason for looking for better things in steel in 1922 is that the history of the trade shows no year in which the output was so small a percentage of capacity as it was in 1921. And the reason for such a record was that the country never entered on a year with so much finished iron and steel in the hands of the manufacturing consumer, or such large warehouse and storeroom stocks of the products of metal-working industries, as existed on Jan. 1, 1921. How the builders of ships, railroad cars, implements, automobiles, electric equipment, machine tools, and the manufacturers of builders' hardware, plumbers' supplies, domestic ware, and the thousand and one articles made from wire, sheets, and tin plates got through the twelve months with so little

call upon the mills was the continuing wonder of the owners of steel plants, who scarcely knew a week ahead whether they would be able to operate.

Scanning the production curves of the last thirty years, to find backing for the hope of larger steel output in 1922 than in 1921, the steel maker sees that in 1894, following the panic year 1893, the line dipped deeply, but came up sharply in 1895. Similarly after 1907, with its November panic, 1908 was a year of low production, whereas 1909 even went beyond 1907. In 1914, with business paralyzed for five months after the outbreak of the war, came another drop, followed by a high figure in 1915.

Coming on to 1920, the crash came in the autumn, so that it was after all a year of good output in steel: then 1921 brought a precipitous drop. The tradition of the trade that a 50 to 60 per cent operation is to be expected, even in depressed times, from mere wear and tear, quite broke down, for at 19,250,000 tons of steel ingots (castings not included), 1921 was something less than a 40 per cent year. That argues strongly for a compensating output in 1922 unless we say that the Great Upheaval has put to confusion all the cycles and the curves.

### The Country Bare of Steel

Putting aside charts and records, the expectation of a larger demand upon the steel mills in the coming year than in 1921 is based in no small part upon the fact that the country has been swept bare of steel in the using up of inventories of every description. That this had gone far in some quarters was shown by the replenishment demand that sprang up last fall and that was more particularly noticeable in the wire and wire nail trade and in tin plates. Jobbers and manufacturing consumers of all forms of steel came to the point where broken stocks had to be patched up, and the aggregate of this imperative buying gave an impulse to the mills that had not exhausted itself at the year's end.

Railroad buying of steel, which includes car and locomotive works buying, was probably much less than 15 per cent of the country's output of 1921. While the railroads are following a very careful policy, and many officials have said they did not feel warranted in increasing their outlay for maintenance until they could make better earnings, the immediate promise for 1922 is for larger railroad buying than for last year.

### Prospects in Other Lines

Building, next to railroad consumption, is thought of as one of the main dependences of the steel industry for the coming year. There has been some liquidation in wages and working conditions in the building trades, but not enough. The amount of house building last year was large. There are prospects of activity on a greater scale this year, but the feeling that labor must come down is more intense.

Agriculture should do more for the steel trade in the new year, but implement makers know that the farmer must harvest another crop before his buying power will count heavily in their behalf. Warehouses are still carrying implements made in 1920, but the liquidation has been steady, and unquestionably the worst has been passed.

The oil fields have come to the rescue of the steel mills in the last few months, and tank work has made up to the plate mills a part of their loss in shipyard tonnage. Pipe-line extensions have helped out also, and a good deal more work of this sort is in prospect.

The motor-car industry exceeded expectations in 1921, but the industry is in a transition, and predictions are made with reserve.

It is fair to look for a considerable consumption of steel in the twelve months just ahead, in the large number of miscellaneous lines not generally enumerated in charting the main feeders of the steel mills. The aggregate of the uncounted uses of steel may be put at 25 per cent of the total. It embraces many wear-and-tear requirements that have not been to the front since the breaking out of the war. They have much to do with replenishment and repair, in the common uses of iron and steel that touch the ultimate consumer.

The foundry industry, which was the buyer of from 7,000,000 to 8,000,000 tons of pig iron per year before the war, fared badly in 1921, steel foundries in particular being sufferers.

### Export Trade in Iron and Steel

In the export trade the outstanding difference between today and one year ago is that the steel companies then had a good-sized carry-over in 1920 business. Half of our shipments of iron and steel into the export trade last year were made in the first quarter. The start in export trade for 1922 is made from the scratch.

Exchange difficulties have not grown less. Some exporters of steel have considerable balances in South American countries which they cannot transfer to the United States because of the losses that would be involved in converting into dollar exchange. Japan is still one of our best customers in steel, taking over 100,000 tons of sheets alone last year. These are used extensively for roofing, for billboards, household utensils, and in a great variety of ways, many of them new. Japan also does a good deal of galvanizing.

### The Course of Prices

One year ago producers of iron and steel in all lines, particularly in pig iron, were giving reasons why the prices of their products could go down little if any until their costs had been readjusted. They believed lower ore, lower coke, and, more important, lower transportation was necessary to any material reduction in the prices of pig iron and finished steel. Events of the year show, however, that prices are made not by costs but by necessity growing out of the relation of supply and demand. Wage reductions have amounted to about 40 per cent in the last year, and in some cases common labor is receiving not more than half its war-time wage. Ore has been reduced, but it is still high in relation to finished material. Carrying charges stand where they were put by the 40 per cent advance of 1920.

The year's decline in pig iron is represented by a composite of $18.68 at the opening of 1922 as against $34.13 one year previous. The market today is but 19 per cent above the ten-year pre-war average of $15.72. The liquidation of finished material has gone far and the stress has been severe. The average price at mill, of the seven leading forms of finished steel—rails, plates, shapes, bars, plain wire, black pipe, and black sheets—was 2.06c. per lb. at the beginning of 1922, against 3.08c. one year previously and a ten-year pre-war average of 1.68c. Thus, finished material is today only 24 per cent above the ten-year average.

While it cannot be said that prices are at the bottom, it is evident that the process of deflation is far advanced. Manufacturers realize at the same time that

the return to a profitable basis must be the road of reduced costs rather than of higher prices. Works managers studied economies from every angle in 1921 and much remains to be done.

Labor troubles may figure in no small way in steel works operations this year. Unemployment is still a serious problem in all centers of steel production. Work at iron mines will be scarce through the winter, and accumulations of ore at lower Lake docks and in blast-furnace yards will still be heavy as the season of navigation opens. So far as the steel industry itself is concerned, the year promises to be as free of strikes as 1921. There may not be two men for one job all the year but at no time will the labor surplus be inconsiderable.

Briefly, the outlook for iron and steel production in 1922 is for some increase upon that of 1921, this expectation being based on the indications that all industries passed their worst point last year and on the fact that the country's consumption of steel in 1921, bad year as it was, was greater than the production. There are no stocks to use up now, and the mills are the sole dependence. Having been slightly under 40 per cent of capacity in 1921, production may reach 50 per cent this year, and at some time in the year a 60 per cent operation may be attained. Prices may go lower than they are today, but reductions would rather be due to lowering of costs than to further cutting by manufacturers that would increase their current losses.

But any prediction of a larger operation in iron and steel in 1922 carries the reservation that the adjustments yet to be made by railroads, coal mines, and the building trades can be brought about without prolonged strikes in those industries.

# Our Foreign Trade in Metals and Minerals

## Record for 1921 Shows a Tendency To Return to Pre-War International Trade Conditions—Copper Exports Increased, While Those of Lead and Zinc Decreased—Tariff Being Strongly Urged by Producers

BY FELIX EDGAR WORMSER
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FOREIGN trade in the metals and minerals is a small part of the foreign commerce of the United States. Although rich in mineral resources, the domestic demand for our own metal products and strong competition from other countries in international trade has left little room to build an export business in any of the non-ferrous metals except copper. The large cheaply mined copper deposits of the United States, American control of South American sources of supply, and the predominance of American refined production in the world's output have combined to make the great European manufacturing nations look to the United States for an adequate supply of copper. Unlike the commerce in other metals, such as lead and zinc, export trade in copper stands squarely on both feet and is able to meet competition from anywhere on the globe. No protection has been necessary to build up the industry.

Although exports of copper in 1921 are estimated to have been slightly smaller than the preceding year, less metal to be refined was imported, so that the record may be considered more satisfactory. The following table brings out this relation:

MOVEMENTS OF COPPER TO AND FROM THE UNITED STATES IN TONS, 1910—1921

| Year | Imports | Exports | |
|---|---|---|---|
| 1910–1913 (Average) | 187,300 | 399,500 | |
| 1920 | 184,616 | 311,810 | |
| | | To France | 59,245 |
| | | United Kingdom | 49,740 |
| | | Germany | 44,590 |
| | | Japan | 41,450 |
| 1921 (eleven months) | 125,778 | 310,000 | |
| | | To France | 45,000 |
| | | United Kingdom | 30,570 |
| | | Germany | 106,000 |
| | | Japan | 23,700 |

One of the surprising features of copper export trade during 1921 was the consistent predominance of German purchases and importations. Month after month, ever since December, 1920, German copper buying has exceeded that of any other nation, and as Germany was the largest consumer of exports before the war, this is a healthy sign of a return to normal conditions. Although Germany ranked third in importance as a copper importer in 1920, she has now moved up to first place. Especially during the last half of 1921 did the imports of France and England decline.

Besides the sales to Europe, the copper sold to Japan in 1921 was highly important and furnished a convenient outlet for copper refined on the Pacific Coast. Since June, 1921, when purchases suddenly began, Japan has been the second largest purchaser of American copper, importing about 8,000,000 lb. monthly. Prior to June, Japanese purchases were negligible.

There is no minimizing the fact that a healthy export trade is necessary for a prosperous copper-mining industry. Without it, as at present, mines will close down. Whether he wills it or not, the American copper producer is vitally concerned in the political and economic developments in Europe and Asia. They directly affect his pocket-book.

The Copper Export Association functioned satisfactorily during 1921, despite criticisms from abroad which predicted its disruption. The association has not stifled competition, as several large producers continue to sell copper abroad independently. Furthermore, Australian and African copper competes with American copper in European markets. For years manufacturers and others in Europe have been organized to enter foreign trade, and American copper producers, in adopting these tactics, are merely playing the same game.

Foreign trade in lead and zinc has reverted almost completely to its pre-war status. During the latter half of 1921, exports of "bonded" lead made from foreign ores were large, due to the attractive lead market in Europe and the possibility of shipping the lead there without the payment of a high duty. Mexican lead is shuttled about in seeking a market; when American prices are higher than those abroad the metal enters the United States; when London prices are better Mexican lead goes abroad. The London market was so

much higher than that of New York in December that domestic lead also was sold to Europe, a most unusual situation and one that is not likely to continue. An estimate of lead movements in tons follows:

| | EXPORTS | | IMPORTS | |
|---|---|---|---|---|
| Year | From Domestic Ores | From Foreign Ores | Lead in Ore and Bullion | Pig Lead and Old |
| 1910–1913..... | ..... | 70,300 | 83,192 | 1,608 |
| 1920..... | 2,735 | 16,837 | 62,796 | 35,719 |
| 1921 (eleven mos.) | 631 | 22,492 | 42,569 | 31,068 |

Lead producers have been active in advocating a higher tariff. The imports of lead from Spain and France early in 1921 lent color to the plea. In May, 23,480,000 lb. and in June, 17,440,000 lb. of lead were imported, the only two months, however, that were favorable for such importations. Attempts are being made to import additional tonnages, but the market is too low and the tariff too high to make importations profitable. On the contrary, American lead, as stated in a preceding paragraph, has gone to Europe.

Zinc producers have accepted the abrupt change from heavy war-time exports of zinc to practically none, a tendency that was forecast long ago. They have been more concerned over importations of foreign zinc, which have encouraged an attempt to obtain a higher protective tariff. In March and April of 1921 large quantities of zinc entered the country, about 6,220,000 lb. in each month, but importations ceased abruptly in April and have been a negligible market factor up to January, 1922. Neither export or import trade in 1921, taken in the aggregate, is worth mentioning. A comparison of foreign commerce in zinc with other years, in tons, follows:

| | EXPORTS | | IMPORTS | | |
|---|---|---|---|---|---|
| Year | From Domestic Ores | From Foreign Ores | In Ore | Blocks, Pigs, | Other Forms |
| 1910–1913..... | 6,300 | 11,100 | 18,110 | 4,300 | 574 |
| 1920 ..... | 74,065 | 28,132 (*a*) | 22,487 | 15 | 17 |
| 1921 (eleven mos.)..... | 1,320 | 640 (*b*) | 2,665 | 6,674 | 15 |

(*a*) Also 11,833 tons of zinc sheets; (*b*) Also 1,655 tons of zinc sheets.

The great unsettlement in the European zinc industry, particularly in Upper Silesia, and the doubtful outlook in other parts of the world, render it difficult to predict how foreign trade in zinc will be affected, but there is little reason to suppose that the situation will be much different from that prevailing before the war.

Of the precious metals, gold, silver, and platinum, import trade has been more important than exports. Gold shipments to the United States were so heavy during the year that record stocks have accumulated—about 40 per cent of the world's gold is now held in this country. Silver imports and exports both show decreases, the Pittman Act naturally diverting all domestic silver to the Treasury. Platinum imports were smaller in 1921, and exports larger, partly accounting for the relatively high price of platinum during the year. Owing to a possible modification in the attitude of European countries and the United States toward Soviet Russia, it would not be surprising if importations of platinum during 1922 showed a marked increase.

A table of imports and exports of the precious metals follows:

| | IMPORTS | | |
|---|---|---|---|
| | Gold | Silver | Platinum |
| 1910–1913 Average ..... | $58,772,000 | $44,868,000 | 116,374 oz. |
| 1920 ..... | 417,068,000 | 88,060,000 | 81,741 oz. |
| 1921 ..... | 691,267,400 | 63,242,670 | 57,055 oz. |
| | EXPORTS | | |
| 1910–1913 Average..... | $69,041,000 | $64,135,000 | 1,080 oz. |
| 1920 ..... | 322,091,000 | 113,616,000 | 1,302 oz. |
| 1921 ..... | 23,680,000 | 51,575,400 | 3,264 oz. |

Imports of the minor metals generally declined during 1921. Imports of nickel dropped from 41,500,000 lb. to 2,200,000 lb., which is expressive of the condition of the nickel market. Imports of aluminum, arsenic, antimony, and the ores used in ferro-alloy manufacture, chromite, manganese, and tungsten, also show decreases. In none of these metals or ores, with the possible exception of aluminum, is export trade important.

IMPORTS OF MINOR METALS AND ORES, 1920-1921.

| | 1920 | Eleven Months, 1921 |
|---|---|---|
| Aluminum, lb..... | 40,074,132 | 26,884,573 |
| Antimony, lb..... | 26,310,530 | 19,062,800 |
| Arsenic, lb..... | 8,160,089 | 6,286,665 |
| Cobalt, lb..... | 157,412 | ..... |
| Iridium, osmium, palladium, oz. ..... | 18,685 | 14,953 |
| Chromite, ton..... | 150,275 | 81,835 |
| Manganese ore, ton..... | 601,437 | 386,454 |
| Tungsten ore, ton..... | 1,740 | 1,424 |
| Monazite, lb..... | 2,810,096 | 542,130 |
| Nickel, lb..... | 41,586,108 | 2,023,681 |
| Tin ore and oxide, ton..... | 30,489 | 13,135 |
| Bars, blocks, pigs, lb..... | 126,038,389 | 45,321,622 |
| Quicksilver, lb..... | 1,072,650 | 528,003 (*a*) |
| Iron ore, ton..... | 1,273,456 | 313,613 |

(*a*) Nine months.

Phosphate rock, sulphur, borax, and salt were the most important non-metallic minerals exported from the United States in 1921, but all show a falling off when compared with the record for 1920. The remaining non-metallics of importance, asbestos, chalk, nitrates, potash, fluorspar, mica, pyrites, talc, and china clay, were imported in smaller quantities, as the following tables indicate:

IMPORTS OF THE NON-METALLICS, 1920-1921

| | 1920 | Eleven Months, 1921 |
|---|---|---|
| Abrasives (corundum) ton..... | 3,374 | 1,496 |
| Asbestos, ton..... | 149,605 | 58,485 |
| Chalk, ton..... | 159,146 | 49,019 |
| Magnesite, ton..... | 43,154 | 46,655 |
| Nitrates (soda) lb..... | 1,321,922 | 363,808 |
| Potash, lb..... | 93,571,981(*a*) | 43,162,697 (*b*) |
| Kainite, ton..... | 53,790 | 58,299 |
| Fluorspar, ton..... | 21,975 | 5,316 |
| Meerschaum, lb..... | 13,386 | 1,731 |
| Mica, lb..... | 1,447,208 | 445,687 |
| Gypsum, ton..... | 265,542 | 224,443 |
| Graphite, ton..... | 18,835 | 7,157 |
| Pyrites, ton..... | 332,606 | 184,065 |
| Talc, lb..... | 43,458,629 | 20,780,447 |
| Mineral wax, lb..... | 4,272,341 | 8,111,423 |
| Sulphur, ton..... | 44 | 4 |
| China clay, ton..... | 323,488 | 119,535 |
| Blue clay and bauxite, ton..... | 49,000 | 31,256 |
| Barytes, ton..... | 24,874 | 6,315 (*c*) |
| Bauxite, ton..... | 42,895 | 24,883 (*c*) |

(*a*) 136,786 tons also came over as muriate and sulphate. (*b*) 66,851 tons also came over as muriate and sulphate. (*c*) Nine months.

EXPORTS OF MINOR METALS AND MINERALS 1920-1921

| | 1920 | Eleven Months 1921 |
|---|---|---|
| Aluminum, lb..... | 9,407,653 | 2,076,244 |
| Asbestos, ton..... | 549 | 463 |
| Bauxite, ton..... | 22,257 | 5,591 |
| Potash, lb..... | 2,819,459 | 297,002 |
| Borax, lb..... | 14,325,037 | 3,658,059 |
| Sulphur, ton..... | 477,450 | 267,179 |
| Clays, ton..... | 117,286 | 40,699 |
| Phosphate, ton | | |
| High-grade hard rock..... | 344,896 | 175,294 |
| Land pebble..... | 693,355 | 506,395 |
| All other..... | 31,761 | 5,236 |
| Iron ore, ton..... | 1,145,037 | 438,126 |
| Nickel, lb..... | 1,215,232 | 425,740 |
| Platinum, oz..... | 1,302 | 3,264 |
| Graphite, lb..... | 1,213,616 | 1,797,066 |
| Quicksilver, lb..... | 116,493 | 27,626 |
| Salt, lb..... | 278,544,338 | 194,530,200 |
| Iron ore, ton..... | 1,145,037 | 438,126 |

For a time in 1921 it appeared that early action would be taken by Congress upon the tariff, but, presumably due to realization that the whole question is inextricably interwoven with the prosperity of the country as a unit and with the larger issues of debt cancellation, excessive gold reserves, and other economic problems of readjustment, a decision and report of the bill have been delayed. Whatever tariff is finally decided upon will have an important effect upon the foreign commerce of the United States in metals and minerals.

# Metal-Market Problem for the Miner

## Conditions Under Which Copper, Copper Ores and Mattes Are Sold —Examples of Sales Contracts—How Silver, Lead, Zinc, and Tin Ores Are Marketed—Tungsten Concentrates—Crude Platinum

BY ALBERT R. LEDOUX
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NUMEROUS INQUIRIES at my office would indicate that some producers of ores and their derivatives, especially those abroad, do not now know where they can best find a market nor what are the usual forms for contracts, especially in view of recently changed conditions; nor how to calculate what net prices they might expect to receive for shipments; and I presume it is to throw a little light on these problems that the Editor of *Engineering and Mining Journal* has asked me to prepare a brief statement which may perhaps serve as a guide to those interested. Doubtless similar requests for information come to the *Journal*.

In addition to these inquiries, despite the fact that my firm are neither brokers nor commission merchants nor dealers in metals, it has happened occasionally that certain producers, particularly some doing business abroad, have consigned material to us for sale. Under such circumstances we have been compelled, however unwillingly, to act, and have placed the ore in the hands of brokers or commission houses to make the best bargain possible for the sellers. We have, however, many copies of contracts made without our intervention which have enabled us to make settlements with buyers or refiners on behalf of the sellers who have retained us not only to sample and assay but to complete the settlements.

As to these forms in general I would say that there is still no fixed standard, though the general tendency is in the direction of simplification, but there are sometimes variations of importance which may be overlooked. For instance, I recall two contracts made about the same time. In one of them it was provided that the payment for the metals contained should be based on the price established so many days after the arrival of the shipment in the buyer's works; in the other, so many days after the shipment arrives at the railroad terminus or at the steamship wharf. The latter form is the one usually adopted, being fair to the shipper and buyer because on a falling market there may be a suspicion that the buyer has induced the railroad company to hold cars in its yards or the captain of a lighter to permit his vessel to remain for a few days, loaded, alongside of the wharf. In that way time might be gained and a lower price paid than in the former instance. Though there are few if any buyers who would thus take advantage of a seller, it is well to eliminate a possible cause of suspicion.

Such occurrences being rare, it may be wondered why I mention one of them, but in past years sellers have, in some instances, discovered that the contract was based on the cost of casting copper, or cathodes, not knowing the difference in the price between these and ingots or wire bars. On a falling market my firm have been accused of delaying the sampling and assaying. We have no control of the sampling date; whenever the buyer is ready to sample we are present, but cannot expedite it. Therefore it is better to take, for the settlement date or quotation date, so many days after the arrival of the material rather than the date of sampling or the date of agreement of assays.

As to the general conditions of payment and the prices which the shipper is to receive for metals, these are, in the East at least, based on quotations for the average of the week of sampling, or for some other period, as stated by *Engineering and Mining Journal*. (The "week" means Thursday to Wednesday.) In some Western sections, however, the price paid is based upon the quotations of the Western Union Telegraph Co., and these, I understand, are obtained from the New York Metal Exchange. In my opinion, the quotations of the *Journal* are most likely to be representative of the actual market conditions, for it has access not only to the files of sellers but those of buyers, and their books are open confidentially for inspection. Furthermore, certain sales of ingots, wire bars, and other forms may not have taken place at the actual price for fine metals named in the contracts, an understanding being, whether stated in writing or not, that an allowance shall be made for all or part of the freight, say, to the Naugatuck Valley, or a special discount for cash payment in, say, New York, or payment deferred for sixty or ninety days without interest charges. These facts are known to the representative of the *Journal* who visits the trade in preparation of quotations, and are allowed for. They sometimes account for differences in quotations as between those issued by the Metal Exchange and those published in the *Journal*.

### COPPER CONTRACTS ARE SIMPLIFIED

It is well known that there are few copper mines the products of which do not contain also certain proportions of other metals, particularly gold and silver, which in early days might not have been paid for but at present are accounted for in settlement. On the other hand, there are undesirable impurities, such as zinc, arsenic, or other metals. In some locations silica is penalized; also, in others, the smelter needs silica and may even have to buy it in the form of quartz or even beach sand, if the ores he smelts do not contain enough.

There was a time when silver in copper matte was not paid for unless it amounted to over 30 oz. per ton. There was therefore an inducement to add silver in some form to shipments of matte, to bring the assay up to or over 30 oz. per ton. In some instances at present, and more largely in the past, American smelters have penalized lead in matte, and of course zinc, antimony, and sometimes bismuth, as indicated before; whereas, on the other hand, some European buyers, particularly those in Germany, have surprised shippers of leady copper matte by paying for the lead also instead of penalizing it.

The tendency of today is in the direction of simplification of contracts. Despite seemingly complicated details of settlement, we have already advanced a long way from the former British terms which paid for copper in ores, concentrates, and mattes on the basis of landing weights in Great Britain. There were arbitrary deductions of so many pounds per ton for "draftage";

others for dock dues, town dues, master porterage fees, or other charges. The copper was paid for not on the electrolytic assay which shows the actual amount of total copper present but on the "produce" based on the supposed imitation in the crucible of smelter operations, and might or might not represent approximately the real amount of copper in the shipment. Then the settlement was based not on so many pence per pound of copper content but upon so many shillings per unit. The unit is 1 per cent per ton; that is to say, a unit of a ton of 2,000 lb. would be 20 lb. and payment would be so many shillings per ton for every 20 lb. of copper present; but the British custom was not based on the unit of the ton of 2,000 lb., nor yet upon the ton of 2,240 lb., but upon the "miner's ton" of 2,352 lb.

All contracts for ore, matte or blister in the United States are now based on the electrolytic assay for copper, but there still lingers an old trade custom of deducting from the electrolytic assay of ores or mattes 1.3 per cent, which is supposed to represent the differenc between electrolytic and "fire" assay. I hope to live to see the day when the payments for copper-bearing material, at least, will be based upon the actual amount present as shown by as perfect an assay as possible, the buyer paying so many cents per pound of copper content, as his knowledge of the character of the shipment and of the difficulty or ease of smelting or refining suggests.

I might interject here also the opinion that shippers would serve their interests best by employing reputable brokers in ores and metals, rather than by attempting to shop around by corresponding with various buyers. This refers particularly to sellers to establishments in the eastern United States. Though the tendency of the age is to get rid of the middleman as far as possible, I do not think the time has yet come when it is advisable to attempt this in connection with the sales of ores and metal products, particularly if the seller has no agent of his own on the spot, or if he be a foreigner unfamiliar with American conditions of marketing.

As an example, a much-condensed suggestion for a contract for the sale of copper matte based on examination of a large number of such contracts in my possession is given herewith. Some of the contracts date back several years; others were entered into during 1921. Matte is gradually disappearing from the market, but numerous mining companies, whose product is hardly large enough to justify the use of converters, or where fuel is unavailable, or other conditions do not admit of reverberatory practice, at least want to know the market for mattes. Suggestions for such a contract follow:

*Contract*—The seller states that he is producing a grade of copper matte running from 35 to, say, 55 per cent copper content, amounting on the average to so many tons monthly. He agrees to deliver this material (with the usual strike and accident clause reserved) at buyer's works or at a certain port during a period of —— years in as nearly as possible equal monthly shipments. The buyer agrees that the material on arrival shall be weighed and sampled by him jointly with Messrs. Doe & Roe, assayers, who shall represent the shipper. The buyer will make his own assays and Messrs. Doe & Roe those for the seller. Extra samples shall be sealed by both parties and held for umpire in case of difference in assays. The splitting limits shall be as follows: For copper, 0.25 per cent; for silver, 1.00 oz. per ton of 2,000 lb.; for gold, 0.03 oz. per ton of 2,000 lb.

If the assays of both parties agree within the foregoing splitting limits, they shall be averaged for settlement; otherwise one of the sealed samples shall be submitted to an umpire agreed upon, the umpire's assay to be averaged with that of the seller or the buyer which is nearest to his figures. If, however, the umpire shall be lower than both buyer and seller, or higher than both buyer and seller, his assay shall be thrown out and the average of the first two assays be taken in settlement. In settlement for the copper the usual trade allowance of 1.3 per cent shall be deducted and the copper paid for at —— cents below the quotation for refined electrolytic ingots or wire bars as given by *Engineering and Mining Journal* of New York City for the average of the week in which the material arrived at (not *in*) the buyer's works or at the nearest port. (In the event of material arriving by ocean steamer, it is more customary, or at least more desirable, that the average of the week shall be taken during which the steamer arrived at the port of discharge. There is a larger deduction from the copper price paid for mattes below 45 per cent and a less deduction for mattes averaging above 50 per cent of copper.)

For the silver present the buyer will pay for 95 per cent of the content as shown by the settlement assay of the average United States or foreign bullion price quoted by *Engineering and Mining Journal* (or Handy & Harman) for the week in which settlement is made.

[Prior to the war, this price for silver was always the New York price, but conditions established by our Government under the Pittman Act have made the American price artificial, whereas the London quotation more normally represents the market price. The American price is based on silver 999 fine; the London price is for "Standard" 925 fine, and the so-called foreign price is quoted here at the New York equivalent. On Dec. 17, 1921, the *Engineering and Mining Journal* quoted United States silver at 99§, and the London price (with exchange at $4.17) at the equivalent of 66¼c. per oz. (The American price is always used for silver originating in this country.)]

All the gold content is to be paid for without deduction at $20 per oz., if over 0.05 oz. per ton.

In many contracts, there are provisions for advances to the shipper on the part of the buyer against railroad or ocean bills of lading, such advances running from 80 to 90 per cent of the assumed value, based either on preliminary sampling or assaying at the shipping point or on the statement of the shippers as to their estimate of the value of the lot. Interest is always charged for such advances. As an indication as to how a settlement of this kind would turn out, I give the figures in the table for a certain lot of imported copper matte, omitting, of course, the names of the contracting parties and the date of the settlement:

SETTLEMENT FOR IMPORTED COPPER MATTE

| | Buyer's Assays | Seller's Assays | Settlement |
|---|---|---|---|
| Copper, per cent | 47.45 | 47.43 | 47.44 |
| Silver, oz. | 0.53 | 0.59 | 0.56 |
| Gold, oz. | 0.10 | 0.10 | 0.10 |
| Moisture | 0.50 per cent | | |
| | | Pounds | |
| Net weight of lot | | 100,000 | |
| Less moisture at 0.50 per cent | | 500 | |
| Dry weight | | 99,500 | |
| Copper assay—47.44 per cent less 1.30 = 46.14 per cent of 99,500 lb. = 45,909 lb. | | | |
| 45,909 lb. copper at 13c. | | $5,968.17 | |
| Less smelting and refining charge at 2.90c. per lb. copper | | 1,331.36 | |
| Value of copper | | | $4,636.81 |
| 95 per cent of silver content at 66¼c. per oz. | | | 17.54 |
| Gold content at $20 per oz. | | | 99.50 |
| | | | $4,753.85 |
| Less advances | | | 4,000.00 |
| Net | | | $753.85 |

The foregoing is nearly an ideal contract, and might, under today's conditions, serve as a practical basis for a sale covering a single shipment or a period of a few months, but perhaps not for a long contract. New long-term contracts now being negotiated or recently entered into both for the sale of copper matte and blister copper recognize the changing conditions of labor and fuel costs, and, as a protection for both parties, include certain "variables," such as a clause providing that "This contract is based on present costs of fuel and labor and shall be readjusted [say] quarterly, as the cost of smelting and refining goes up or down."

The contracts for blister copper, say 98 per cent fine, are somewhat similar in their terms to those above out-

lined for matte, and in some of them, instead of the 1.30 deduction from the copper assay, there is a deduction of five pounds of copper, or some other figure, per ton of bars, to cover losses in process. There is or should be a penalty against non-fulfillment of contract on the part of the seller, especially in all long contracts where the works depend almost entirely upon this particular seller and would have to shut down in whole or in part if he failed to live up to his agreement. Of the copper, as found by assay, 99.75 per cent is paid for at the market price upon the agreed day of settlement. Of the silver, 95 per cent is paid for if less than 50 or 60 oz. per ton; if over 50 or 60 oz. per ton, the excess over the agreed limit is subjected to a further deduction of 5 per cent. All the gold is paid for at $20 per oz. There is a smelting or refining charge of, say, $27.50 per ton.

The calculation of the out-turn under this basis is, after all, not complicated, although I still think it would be better, where the copper constitutes the greatest element of value in the shipment, to do away with the refining charge entirely and to pay so many cents less than the value of the copper as established by the quotation accepted, but where it is simply a refining contract and the copper is returned to the shipper or sold for his account, the element of possible additional gain to the refiner, due to increase in the market, is removed from his estimate of profit.

There is usually insistence on the part of the buyers that moisture occluded in blister copper shall be deducted. It is found in some instances that the tops of the bars are porous and that if a shipment is rained on there is an appreciable amount of moisture present, and when the metal has been water-cooled in casting, this occlusion may be deep-seated and the weight thereby considerably increased. It is not infrequent that in drilling such blister copper for a sample the drill will enter a cavity half filled with water.

The contracts for copper ores differ considerably. The following are fairly typical of those entered into by two great metal houses in the East:

A—Copper paid for less 1.30 at the *Engineering and Mining Journal's* average quotation for the week in which sampling takes place—less a deduction of 2c. from this quotation. All gold paid for at $20 per oz. Ninety-five per cent of silver content paid for at Handy & Harman's quotation for the week of sampling. Treatment charge, $2 per ton of 2,000 lb., based on net, dry weight. Splitting limits: For copper, 0.2 per cent; for silver, 0.8 oz. per ton of 2,000 lb.; for gold, 0.05 oz. per ton of 2,000 lb. Payment sixty (60) days after arrival of importing steamer at New York. Delivery, c.i.f. New York. Assays settled between buyers and Doe & Roe, representing sellers. Usual umpiring clause. Empty bags to be returned to seller or sold for his account.

B—Delivery f.o.b. smelter's wharf, or c.i.f. New York. In latter case seller pays cost of lightering—say, $1.50 per ton. Copper less 1.30 paid for, less —— cents smelting and refining charge. Silver, if over 1 oz. per ton, 95 per cent paid for. If ore is of American origin, silver is paid for on the New York quotation; if of foreign origin, on the New York equivalent of the foreign price for silver. Gold, if over 0.05 oz. per ton, paid for at $20 per oz. Smelting charge of $ —— per ton. If ore is so fine that it must be briquetted, —— cents per ton is charged for briquetting. (This relates chiefly to concentrates. This degree of fineness is based on a test: If 35 per cent or over goes through a ¼-in. mesh screen, the penalty is enforced.)

Excess of alumina ($Al_2O_3$) over —— per cent is penalized; also zinc in excess of —— per cent; likewise arsenic, antimony, and bismuth. Neutral ores are desirable, and any excess over an agreed maximum of silica and (or) iron penalized at —— cents per unit.

Date of payment, —— days after arrival, or of agreement of assays, or after sampling or according to other terms of the agreement.

Some ores are imported which are most valuable for their silver content, lead being negligible, although both gold and copper are paid for. These ores have sold, under the most recent contracts, on the following basis: Ninety-eight and one-half per cent of the silver ascertained by assay is paid for at the New York price for foreign silver as quoted by *Engineering and Mining Journal* on the tenth day after the date of sampling, provided the silver content is under 6,000 oz. per ton of 2,000 lb. If the silver content is 6,000 oz. or over, 99 per cent of the content is paid for. If there happens to be no quotation for silver on the date above mentioned, the quotation for the day next following applies. All the gold is paid for at $20.60 per oz. If copper is present to the extent of 10 per cent or over, 1.30 being first deducted from the assay, this copper is then paid for at 3c. below the New York price of electrolytic copper as quoted by the *Engineering and Mining Journal* on the same day taken for the silver valuation. There is a smelting charge of $25 per ton of 2,000 lb., based on the net dry weight of material. Payment twenty days after sampling at buyer's works; delivery at buyer's works.

### Lead Ore Settlements Complicated

With respect to lead ores, diverse conditions must be considered. Contracts vary as between low- and high-grade lead ores, between Western and Eastern terms, and between American and imported products. Most of such ores arriving at works on the Eastern seaboard are of a low grade and carry, naturally, silver. Here are two typical contracts:

A—Ninety per cent of the lead content is paid for on the wet assay, less 1.50 per cent; that is to say, if the ore contained 15.50 per cent lead by wet assay, 14 per cent is paid for. The price is based on the New York quotation of *Engineering and Mining Journal* on the tenth day after the date of sampling at buyer's works and after further deduction from the assay of 3 per cent. In this instance, on the above assumption, the lead content, which is supposed to have been 15.50, and 14 per cent after the deduction of 1.50 per cent, is subjected to a further deduction of three points; that is to say, 11 per cent net will be paid for. In addition, a deduction to cover part of the supposed smelting costs is made at the rate of ½c. per lb. There is the provision that the quotation shall be taken as of the day of sampling or upon the next day if there be no quotation. One important point is that in transactions involving the sale of dutiable ores, the import duty is paid by the seller. If gold is present to the extent of 0.05 oz. per ton of 2,000 lb. or over, all is paid for at the rate of $20 per oz. Ninety-five per cent of the silver content is paid for at the *Engineering and Mining Journal's* quotations for foreign silver as of the day when the quotation for lead is taken.

There is a penalty for zinc present at the rate of 50c. per unit on any excess over 8 per cent. A penalty likewise for arsenic of $1 per unit on all present over 2 per cent. There is a smelting charge of $10 per ton on the net dry weight of ore. The delivery is c.i.f. New York and the payment forty days after arrival of steamer at the port of New York. Conditions of sampling and assaying are as in previous contracts.

It will be seen that this is a complicated method of figuring, and I append at this point the results of a recent settlement on ores of this class:

If there be brokerage or commission it will be deducted in remitting the net proceeds as above. In some transactions, bags if in good order are returned to seller by freight at his expense; otherwise they are sold for

his account either as second-hand bags or junk, and the proceeds remitted.

INVOICE FOR 960 BAGS LEAD ORE EX STEAMSHIP

| | | Pounds |
|---|---|---|
| 960 bags weighing | | 96,483 |
| Moisture 0.3 per cent | | 289 |
| | | 96,194 |
| Gold—0.03 oz. per 2,000 lb. | | |
| Silver—172.20 oz. per 2,000 lb. = 8,282.30 oz. 95 per cent = 7,868.18 oz. at 69.625c | | $5,478.22 |
| Per Cent | | |
| Lead—23.66 | | |
| −1.50 | | |
| 22.16 | | |
| −3.00 | | |
| 19.16 per cent = 18,430 lb. | | |
| | Cents | |
| 90 per cent = 16,587 lb. at | 4.675 | |
| | 0.500 | |
| | 4.175 | 692.51 |
| | | $6,170.73 |
| Refining charge at $10 per ton | $480.97 | |
| Zinc 15.26 per cent penalty over 8 per cent = 7.26 per cent. 349.18 units at 50c | 174.59 | |
| Arsenic 2.5 per cent penalty over 2 per cent = 0.5 per cent. 24.05 units at $1 | 24.05 | 679.61 |
| Net proceeds | | $5,491.12 |

B—*Delivery*—F.o.b. smelter, or c.i.f. New York; in the latter arrangement, lighterage charges being for account of seller.

*Lead*—90 per cent of the lead contents, as per dry assay, that is, wet assay less 1½ units is paid for at the New York quotation or London quotation for pig lead, less a refining charge of 1½c. per lb. of lead paid for.

*Silver*—If contents exceed 1 oz. per ton of 2,000 lb., 95 per cent of the silver content (minimum deduction 1 oz. per ton of 2,000 lb.) is paid for at the New York price of silver as quoted by Handy & Harman. Because of the operation of the Pittman Act, if the silver is of domestic origin the New York quotation for domestic silver is stipulated; if of foreign origin, the New York foreign price of silver is stipulated.

*Gold*—If content exceeds .05 oz. per ton of 2,000 lb., all gold is paid for at $20 per oz. No payment is made for gold if content is .05 oz. or below per ton of 2,000 lb.

*Smelting Charge*—$15 per dry ton of 2,000 lb. of ore.

*Penalties—Sulphur*—Content in excess of —— per cent penalized at —— cents per unit per dry ton of 2,000 lb. ore. *Zinc*—In excess of 8 per cent penalized at 50c. per unit per dry ton of 2,000 lb. ore. *Arsenic, antimony, and bismuth combined*—In excess of 1 unit penalized at 50c. per unit per dry ton of 2,000 lb. ore. *Tin*—In excess of —— per cent penalized at —— cents per unit per dry ton of 2,000 lb. ore.

Payment for precious metals, and charge for smelting and refining is due sixty-days after date of sampling. This is at times varied, fixing payment thirty days after date of agreement of assays or after arrival of the material at works or port of entry.

Only a small amount of zinc ore is imported, and, indeed, much less than was previously produced under 1921 conditions. The usual "Joplin terms" are based on 60 per cent of zinc, paid for at the price ruling or agreed upon, less a deduction or addition of $1 per unit per ton of 2,000 lb. in accordance as the assay goes below or above 60 per cent. .

Tin ores are becoming more and more an important import, though there are as yet only three or four buyers. Here is a recent contract:

Tin content is paid for at the average of cash and three months' prices of standard tin as quoted in London during the two calendar weeks following the arrival of the importing steamer at the port of discharge, these quotations being converted into United States currency at the average of the demand rate of exchange on London which rules on the days which are taken for pricing. There is a treatment charge of about $85 per ton of 2,240 lb., based on the net dry weight of ore and on a tin content of 60 per cent.

For each unit of tin content below or above 60 per cent, $1 per ton is to be added to or deducted from treatment charge; fractions pro rata. It will be noted that the unit of this ton is 22.40 lb. and that the variant of $1 is based on the ton of 2,240 lb., not on the ton of 2,000 lb.

Usual terms of payment are cash thirty days after arrival of shipment at buyer's works. The delivery, however, is at the dock in New York City, if the ore, as is usually the condition, is sold to smelters in the vicinity of New York. The assays are made under the same conditions as those outlined for copper shipments. Sampling takes place at buyer's works. The seller pays the charges of assayers who represent him in weighing and sampling control.

Shipments of tungsten concentrates still come in, though at an ever-diminishing rate, and buyers are more and more particular. They are sold on a simple contract based on the unit of tungstic oxide ($WO_3$). These have been generally sold on the weights and assays of one firm of chemists, if coming to New York, but I believe that it is always better that the weighing should be made jointly by buyers and the representatives of the sellers, and that assays should be compared, the average taken, and a provision made for umpiring in case of difference. This avoids complications and claims against either the seller or the assayers representing both parties. It is more satisfactory that assays be compared, and if there be any serious differences, either party or both parties should reassay or an umpire satisfactory to both be selected.

Though the settlement, when determined, is simple, conditions as to grade and impurities are important. The shipment is usually sold on a guarantee of 60 per cent of tungstic oxide—sometimes 65 per cent. Some buyers refuse the lot if tin, phosphorus, arsenic, sulphur, copper, bismuth, or manganese are present in excess of certain specified amounts—e.g., copper over 0.05 to 0.10 per cent. Phosphorus must be below 0.05 per cent and other requirements of like nature observed.

In the Chinese product, though tin is present, the concentrates are taken, at a price, and the tin and some other impurities are separated, before treatment in the electric furnace.

With the increasing amounts of crude platinum coming to New York, there has gradually developed a standard for its sale. The quotations of *Engineering and Mining Journal* are not taken as a rule, in the settlement under contracts, largely because there are so few buyers of crude platinum, and they apparently establish a price either by conference or otherwise. Most of the crude coming forward contains upward of 80 per cent platinum, 1 to 2 per cent gold, about 2 per cent of osmiridium, and from 0.6 to 1 per cent of palladium, and is consigned to banks or other houses having Central American connections. The banks make advances to the shipper and sell the platinum at a price high enough to protect themselves, of course getting as much as possible in addition for the shipper. The buyers usually state what they would consider to be the market price of platinum and pay about $2 per oz. below this price for the platinum content of the shipment. All of these crude platinums contain osmiridium and palladium as well as other of the rare metals, and also gold. For the osmiridium present buyers pay from 45 to 50 per cent of the agreed price for platinum content; for palladium they pay about $20 per oz.[1] below the platinum price, and for all the gold $20 per oz. Nothing is paid for the small quantities of other rare metals, if present.

[1]This is not a fixed price for palladium, but varies frequently and considerably.

# Future of the Non-Metallic Minerals

## Analysis of Inefficiencies in Mining, Milling and Marketing—Grade Association Movement—Consolidation of Small Companies—Improvements In Methods and Utilization

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THE INEFFICIENCIES which long have characterized the production, treatment, and utilization of many of the non-metallic minerals have at last begun to attract the serious attention of engineers, chemists, and even financiers. There are many signs indicating that the non-metallic mineral industries are entering upon a new era. Improvements in methods and equipment are being forced upon the producers by many circumstances and conditions.

Before discussing the causes for and means of improvement, it may be well to summarize some of the present and past inefficiencies. These may be grouped under mining, milling, and marketing, and are as follows:

### MINING

1—Lack of knowledge of markets, causing unwise ventures.
2—Lack of knowledge of deposits, resulting in improper methods of development and mining, low grade of product, premature exhaustion of deposits, unwise location of waste dumps, and other adverse conditions.
3—Lack of engineering and technical control of operations, resulting in wastes, inefficiences, accidents and high costs.
4—Lack of adequate financing, either for equipment or working capital.

### MILLING

1—Use of improper and inadequate materials and machines, resulting in high costs and poorly prepared products.
2—Absence of technical and chemical control of processes resulting in poorly prepared products lacking in uniformity.
3—Production on too small a scale to permit economies in methods, equipment, and marketing.
4—Lack of co-ordination between mine and mill, caused by mill owner not controlling source of raw material.

### MARKETING

1—Lack of standardized grades, tests and specifications, making uniformity of products impossible.
2—Marketing through jobbers and brokers, rather than direct, rendering impossible the necessary direct contact between producer and consumer.
3—Lack of knowledge by producers of consumers' needs as to grades of product.
4—Lack of knowledge by consumers as to the sources of their raw materials and as to the requisite physical and chemical properties of such materials.

As long as costs, prices, and freight rates were low, the importance of remedying some of the difficulties enumerated was not so urgent. Moreover, consumers had not realized keenly the necessity of a careful technical study of their raw materials. But within the last few years high costs and prices have caused consumers to seek better quality, to set up more rigid standards and tests, and to seek lower-priced raw materials. High freight rates have caused them to seek to supply their needs from nearer sources.

Potters have learned that low-grade feldspar, not uniform in qualities, causes high kiln losses, that such losses can be reduced by obtaining a high-grade, standard feldspar, and that it is good business to pay higher prices to guarantee high quality. Old-fashioned producers have found their methods and equipment inadequate to meet the rising standards, and they are being forced to improve or lose their customers to more progressive competitors.

### TENDENCIES TOWARD IMPROVEMENT

Changes and improvements now going on are taking several forms. The most important of these are the trade association movement, consolidation of small companies into larger units, acquiring of sources of raw materials by comsuming companies, operation of several smaller companies under technical and managerial control from a parent company, and new, independent, unit companies. It is interesting to note that marked improvements by long-established companies acting as individuals are not common. The reasons for this are either conservatism or too high capital investment, caused by poor accounting or unwise ventures.

The trade association has been the most important factor in increasing prosperity and raising general efficiency in many industries. In a few instances, such associations have given too much attention to price fixing and have got into difficulties with the Government. But by far the majority of the trade associations in the mineral industries are honestly and energetically seeking to improve methods and equipment, to standardize products, devise new uses, encourage research, and expand markets by advertising and publicity. The association does for the small producer many of the things which he cannot do for himself. Some of the most valuable results of association work have been the setting up of uniform standards for products and method of testing, through co-operation with the American Society for Testing Materials and various governmental agencies, such as the Bureau of Standards, the Bureau of Mines, the Bureau of Public Roads, and other public boards and bureaus.

### BENEFITS OF CONSOLIDATION

The consolidation of smaller companies into larger units has taken place in several industries, and has been beneficial to producers and consumers alike. It has cut down overhead, substituted all the financial and operating advantages of large companies for the disadvantages and handicaps of small companies, promoted efficiency of operations, made more uniform and better products, and tended to lessen senseless and ruinous competition.

The tendency of consuming companies to acquire their own sources of raw materials is becoming more marked each year, and will become a menace to the independent producer unless the fundamental causes for such action are removed. Paper companies are acquiring their own clay and limestone deposits; potters are grinding their own feldspar; chemical companies are opening limestone deposits and burning their own lime. In many, probably most, instances the consuming companies have no desire to enter the mineral field, but they are

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forced into it through their inability to obtain proper materials from present producers. Often they do not understand their new field and waste much time and money before they produce regularly, but they eventually succeed and are satisfied even if their costs are somewhat higher than good management can sanction. It would be well for present producers to note this tendency and seek to remove every cause for dissatisfaction with their product before their markets are permanently closed to them.

The operation of several smaller companies under technical and managerial control by a larger parent company as yet has been attempted only by a few organizations and on a small scale; but for some of the minor, non-metallic mineral industries this plan offers the greatest advantages with the least risk. It gives all the financial power and stability of a large company, at the same time furnishing the necessary specialized technical, managerial, and sales technique for each individual project. It minimizes the financial risk by distributing it over a number of dissimilar but related projects. It seems probable that this type of organization will become increasingly important. Independent unit companies will probably always continue to spring up, but the need for large-scale operations will make the success of this type of organization increasingly difficult.

### Improvement in Mining and Milling Methods

Marked improvements in methods of mining and milling must, in many instances, imply larger-scale operations, control by larger companies, or co-operative effort through trade associations or similar agencies. Many labor-saving devices cannot be used economically on small tonnages, and some types of machines are not made in small sizes. Adequate engineering and technical control involves the employing of high-salaried men, which small companies, working independently, cannot afford. It should not be implied that large companies are always operated efficiently, for some of the largest companies are grossly inefficient. But large companies can afford economies of operation not available to smaller organizations.

The essential points of successful operation of mines and mills, assuming adequate and well-located deposits of raw material of commercial grade, are efficient engineering and chemical control and adequate capital. Technical control will insure reasonable costs of production, uniformly high grades of product, and the keeping pace with improvements in methods and equipment. Adequate capital is needed for the purchase of equipment necessary to efficient operation, to tide over market depressions, and to provide sufficient working capital so that raw material and finished products may be stocked and customers' accounts be carried without the need for selling through jobbers.

The tendency toward greater utilization of labor-saving machines and equipment is marked. This change has been prompted by high labor costs, inefficiency of labor, the development of more efficient machinery, needs for greater speed of production and larger output, and gradual exhaustion of the more easily and cheaply minable deposits.

As the non-metallic minerals become more the subject of scientific investigations and research, new uses will be found for materials now produced, as well as for materials not now mined or discarded as waste in mining other products. An illustration of this tendency is the recent widespread interest shown in bentonite. Several new companies are now producing this material, hitherto mined in only small quantities, and through systematic study and investigation, are introducing it into many industries. A petroleum company in California has discovered a method of chemical treatment of a bentonite found in that state whereby it produces a bleaching agent for petroleum five times as powerful as the best fuller's earth. The utilization of New Jersey greensand for the extraction of potash is another well-known example.

### Great Waste in Slate Quarrying

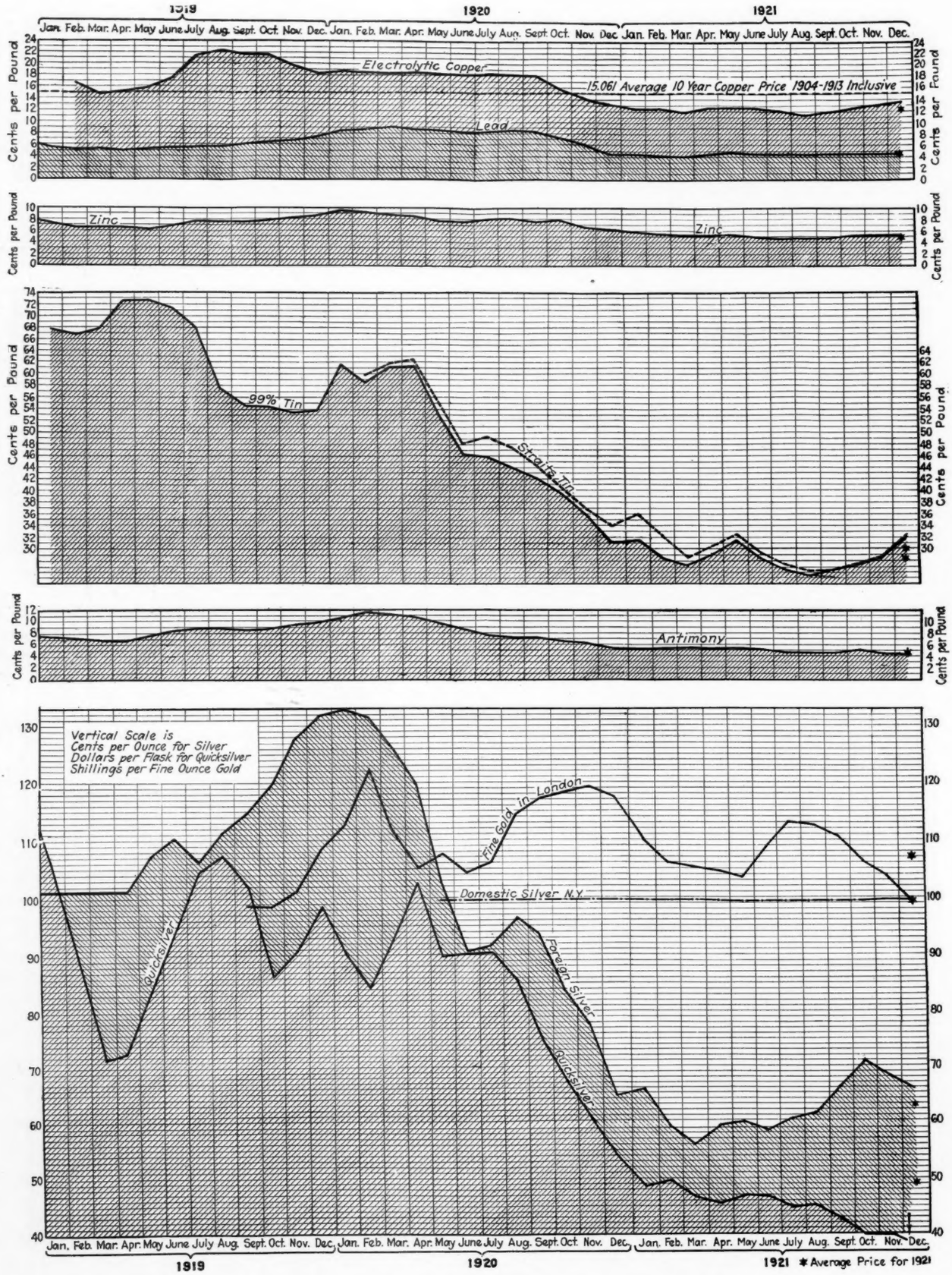
The quarrying of slate involves the production of large amounts of waste, sometimes as high as 80 per cent. Recent investigations by Oliver Bowles, of the U. S. Bureau of Mines, have shown that this waste slate may be pulverized and used advantageously as a filler in road asphalt mixtures, in pressed and molded rubber goods, and for other purposes. Biotite, or black mica, has always been a worthless waste product in quarrying feldspar, but recent developments indicate the possibility of a market for fairly large quantities of this material.

Consumers of the non-metallic minerals are beginning to study their raw materials more critically and to formulate ideal specifications to fit their needs. The filling of these specifications requires a careful survey of available materials, which often results in opening new deposits.

Many of the non-metallic mineral industries have sought high tariff protection and have insisted that without such protection the domestic industries cannot live. Among the industries seeking such protection are graphite, magnesite, potash, mica, talc, barytes, fluorspar, and high-grade clay. It is true that some domestic industries cannot survive without protection, but whether or not such protection is desirable from a national standpoint has been questioned.

No one can predict the amount of tax which will be granted in the final tariff bill, but it probably can be assumed that most minerals will be accorded some degree of protection. However, it has been predicted that the rates granted in the Fordney Bill, which passed the House of Representatives, will be generally scaled down before the final passage of the bill. Without high protection, the domestic production of some of the non-metallic minerals will undoubtedly decline, or, rather, some of the non-metallic industries will not recover from their present depressed condition. But the surviving companies will be the stronger and more efficient ones, and the technology may be improved thereby.

The future promises improvements in the non-metallic mineral industries in many directions. These may be summarized as follows: Wider recognition of the importance of the non-metallics by producers, consumers, engineers, chemists, and investors; increased production and wider utilization of products; larger and stronger producing companies; improved methods of mining and milling; better standardization of products and methods of testing; better and more uniform grades of product, made necessary by better informed and more intelligent utilization; wider utilization of new products and of present waste products; greater co-operation among producers for the general benefit of their industries; increasing use of mechanical equipment to supplant hand labor; development of new machines specifically adapted to the milling of the non-metallic minerals.




MONTHLY AVERAGE PRICES OF METALS

# Mining Dividends

DIVIDENDS OF MINING AND METALLURGICAL COMPANIES IN THE UNITED STATES, 1920 AND 1921

| Company Name | Situation | Shares Issued | Par Value | Dividends Paid 1920 Per Share | 1920 Total | 1921 Per Share | 1921 Total | Total to Date | Latest Date | Latest Amount |
|---|---|---|---|---|---|---|---|---|---|---|
| Ahmeek, c. | Mich. | 200,000 | $25 | $1.50 | $300,000 | ..... | ..... | $12,150,000 | Sept. '20 | $0.50 |
| Am. Sm. & Ref. | U. S.-Mex. | 609,980 | 100 | 4.00 | 2,439,920 | $1.00 | 609,980 | 46,465,579 | Mar. '21 | 1.00 |
| Am. Sm. & Ref., pfd. | U. S.-Mex. | 500,000 | 100 | 7.00 | 3,500,000 | 7.00 | 3,500,000 | 75,796,387 | Dec. '21 | 1.75 |
| Am. Smelters, pf. A. | U. S. | 95,994 | 100 | 6.00 | 571,536 | 6.00 | 575,964 | 72,872,350 | Oct. '21 | 1.50 |
| Am. Smelters, pf. B. | U. S. | 30,974 | 100 | 5.00 | 150,601 | 5.00 | 154,870 | 14,289,108 | Oct. '21 | 1.25 |
| Am. Zinc, Lead & Sm. pfd. | U. S. | 80,540 | 25 | 6.00 | 483,240 | ..... | ..... | 2,188,401 | Nov. '20 | 1.50 |
| Anaconda, c., s. z. | Mont. | 2,331,250 | 50 | 4.00 | 10,490,625 | ..... | ..... | 175,938,750 | Nov. '20 | 1.00 |
| Argonaut Consol., g. | Cal. | 200,000 | 5 | .10 | 10,000 | ..... | ..... | 1,940,000 | Mar. '20 | 0.05 |
| Arizona Copper | Ariz. | 1,519,896 | 5sh. | 9d. | £56,996 2/0 | ..... | ..... | £4,637,894 | May '20 | 9d |
| American Metal | U. S. | 140,000 | 100 | ..... | 1,400,000 | 6.00 | 840,000 | (Not reported) | Dec. '21 | 6.00 |
| Barnes-King Dev., g. | Mont. | 400,000 | 5 | .15 | 60,000 | ..... | ..... | 440,000 | Aug. '20 | 0.05 |
| Bunker Hill & Sullivan, l. s. | Ida. | 327,000 | 10 | 6.00 | 1,962,000 | 3.00 | 981,000 | 26,174,250 | Dec. '21 | 0.25 |
| Caledonia Mining, l. s. | Ida. | 2,605,000 | 1 | .07 | 208,400 | 0.01 | 26,050 | 4,308,306 | Jan. '21 | 0.01 |
| Callahan Zinc Lead, z. | Ida. | 464,990 | 10 | 2.00 | 755,606 | ..... | ..... | 7,721,688 | Dec. '20 | 0.50 |
| Calumet & Arizona, c. | Ariz. | 642,521 | 10 | 4.00 | 2,570,084 | 2.00 | 1,285,043 | 46,915,514 | Sept. '21 | 0.50 |
| Calumet & Hecla, c. | Mich. | 100,000 | 25 | 5.00 | 500,000 | ..... | ..... | 152,250,000 | June '20 | 5.00 |
| Camp Bird pfd., g. s. | Col. | 649,625 | £1 | 7% | £45,473.75 | ..... | ..... | ..... | July '20 | 8 2/5d |
| Cardiff, l.g. | Utah | 500,000 | $1 | .15 | $75,000 | ..... | ..... | 875,000 | Dec. '20 | 0.15 |
| Central Eureka, g. | Cal. | 392,616 | 1 | .32 | 125,637 | 0.06 | 23,557 | 1,087,296 | Mar. '21 | 0.06 |
| Champion, c. | Mich. | 100,000 | 25 | 6.00 | 600,000 | ..... | ..... | 25,850,261 | Apr. '20 | 6.00 |
| Chief Consolidated, s.g.l. | Utah | 884,022 | 1 | .40 | 353,689.20 | 0.20 | 176,805 | 2,048,323 | Nov. '21 | 0.05 |
| Chino Copper | N. M. | 869,980 | 5 | 1.12½ | 978,728 | ..... | ..... | 29,991,710 | Sept. '20 | 0.375 |
| Copper Range, c. | Mich. | 494,363 | 25 | 1.50 | 592,500 | ..... | ..... | 26,998,345 | Sept. '20 | 0.50 |
| Cresson Consol., g. | Col. | 1,220,000 | 1 | .20 | 244,000 | ..... | ..... | 8,857,163 | June '20 | 1.00 |
| Daly, s. l. g. | Utah | 150,000 | 20 | .30 | 30,000 | ..... | ..... | 3,142,500 | July '20 | 0.10 |
| Daly West, s.l. | Utah | 250,000 | 20 | .90 | 225,000 | ..... | ..... | 6,868,000 | Dec. '20 | 0.25 |
| Davis Daly, c.s. | Mont. | 600,000 | 10 | .25 | 150,000 | ..... | ..... | 900,000 | Mar. '20 | 0.25 |
| Dragon Con., s.c.l.g.i. | Utah | 1,875,000 | 1 | .02 | 37,500 | ..... | ..... | 206,250 | Apr. '20 | 0.01 |
| Eagle & Blue Bell, l.s. | Utah | 893,146 | 1 | .35(a) | 312,601 | 0.05 | 44,657 | 1,607,663 | Apr. '21 | 0.05 |
| Electric Point, l. | Wash. | 793,750 | 1 | .18 | 142,875 | ..... | ..... | 444,500 | Oct. '20 | 0.12 |
| Federal M. & Sm., pfd. | Ida. | 120,000 | 100 | 6.00 | 720,000 | 4.00 | 480,000 | 16,413,837 | Dec. '21 | 1.00 |
| Gemini, g.s. | Utah | 5,000 | 100 | 6.00 | 30,000 | ..... | ..... | 2,490,000 | Aug. '20 | 6.00 |
| Gold Chain, s.l.g. | Utah | 1,000,000 | 25 | ..... | ..... | 0.01 | 10,000 | 140,000 | Jan. '21 | 0.01 |
| Golden Cycle, g. | Col. | 1,500,000 | 1 | .08 | 120,000 | 0.08 | 120,000 | 9,633,300 | Dec. '21 | 0.02 |
| Grand Central, g. | Utah | 500,000 | 1 | .03 | 15,000 | 0.01 | 5,000 | 1,830,250 | Jan. '21 | 0.01 |
| Granite Gold Mng. Co. | Col. | 1,650,000 | 1 | ..... | ..... | 0.03 | 49,500 | 418,500 | Feb. '21 | 0.03 |
| Hecla Mining, l. s. | Ida. | 1,000,000 | 0.25 | .65 | 650,000 | 0.50 | 500,000 | 9,505,000 | Dec. '21 | 0.17 |
| Homestake, g. | S. D. | 251,160 | 100 | ..... | ..... | 2.00 | 502,320 | 42,924,664 | Dec. '21 | 0.25 |
| Inspiration Consol., c. | Ariz. | 1,181,967 | 20 | 5.00 | 5,909,835 | ..... | ..... | 38,983,701 | Oct. '20 | 1.00 |
| Internat. Nickel pfd. | U. S.-Can. | 89,126 | 100 | 6.00 | 534,756 | 6.00 | 534,756 | 8,555,982 | Nov. '21 | 1.50 |
| Iron Blossom, s.l.g. | Utah | 1,000,000 | 0.10 | .05 | 50,000 | 0.025 | 25,000 | 3,300,000 | Dec. '21 | 0.025 |
| Iron Cap Copper | Ariz. | 142,100 | 10 | .50 | 71,050 | ..... | ..... | 1,031,893 | Sept. '20 | 0.25 |
| Judge Min. & Sm. s. l. | Utah | 480,000 | 1 | .37½ | 180,000 | ..... | ..... | 2,550,000 | Sept. '20 | 0.125 |
| Kennecott Copper | Alaska | 2,787,121 | ..... | 2.00 | 5,574,162 | ..... | ..... | 53,502,411 | Dec. '20 | 0.50 |
| Marsh Mines Con. | Ida. | 1,980,000 | 0.25 | ..... | ..... | 0.02 | 40,000 | 40,000 | June '21 | 0.02 |
| Miami Copper | Ariz. | 747,114 | 50 | 2.00 | 1,494,228 | 2.00 | 1,494,228 | 24,444,887 | Nov. '21 | 0.50 |
| Mohawk, c. | Mich. | 100,000 | 25 | 5.50 | 550,000 | ..... | ..... | 9,675,000 | Nov. '20 | 1.00 |
| National Lead | U. S. | 206,554 | 100 | 6.00 | 1,239,324 | 6.00 | 1,239,324 | 10,999,001 | Dec. '21 | 1.50 |
| National Lead pfd. | U. S. | 243,676 | 100 | 7.00 | 1,705,732 | 7.00 | 1,705,732 | 23,880,248 | Dec. '21 | 1.75 |
| Nevada Consol. Copper | Nev. | 1,999,457 | 5 | .75 | 1,499,592.75 | ..... | ..... | 46,768,627 | Sept. '20 | 0.25 |
| New Cornelia Copper | Ariz. | 1,800,000 | 5 | .50 | 900,000 | ..... | ..... | 1,350,000 | Aug. '20 | 0.25 |
| New Jersey Zinc | U. S. | 454,664 | 100 | 12.00 | 6,100,000 | 8.00 | 3,498,656 | (Not reported) | Nov. '21 | 2.00 |
| North Star, g. | Cal. | 250,000 | 10 | 0.30 | 75,000 | 0.20 | 50,000 | 5,662,040 | Mar. '21 | 0.20 |
| Oroville Dredging, g. | Cal. | 686,538 | £1 | 1/6 | £51,490,135 | 9d | £25,745 | £454,781 | Mar. '21 | 9d |
| Osceola Consol., c. | Mich. | 96,150 | $25 | $1.00 | $96,150 | ..... | ..... | $17,756,375 | June '20 | 0.50 |
| Phelps Dodge Corp. | U. S. | 450,000 | 100 | 10.00 | 4,500,000 | 5.50 | 2,475,000 | 98,846,000 | Oct. '21 | 1.00 |
| Portland Gold | Col. | 3,000,000 | $1 | .06½ | 195,000 | ..... | ..... | 11,692,080 | Oct. '20 | 0.015 |
| Quincy Mining | Mich. | 110,000 | 25 | 1.00 | 110,000 | ..... | ..... | 27,002,500 | Mar. '20 | 1.00 |
| Ray Consol, c. | Ariz. | 1,577,179 | 10 | 1.00 | 1,577,179 | ..... | ..... | 25,412,621 | Dec. '20 | 0.25 |
| Silver King Coa. | Utah | 1,250,000 | 5 | ..... | ..... | 0.15 | 187,500 | 15,386,060 | May '21 | 0.15 |
| St. Joseph Lead | Mo. | 1,549,369 | 10 | 2.00 | 2,889,371 | 1.00 | 1,549,364 | 23,304,375 | Dec. '20 | 0.25 |
| Shattuck Arizona, c. | Ariz. | 350,000 | 10 | .25 | 87,500 | ..... | ..... | 7,612,500 | Jan. '20 | 0.25 |
| Tamarack & Custer, l. s. | Ida. | 1,776,288 | 1 | ..... | ..... | 0.04 | 75,091 | 590,209 | Jan. '21 | 0.04 |
| Texas Gulf Sulphur | Texas | 635,000 | 10 | ..... | ..... | 1.00 | 635,000 | 635,000 | Dec. '21 | 1.00 |
| Tintic Standard, l. s. | Utah | 1,174,700 | 1 | .50 | 587,350 | 0.15 | 176,208 | 1,714,546 | Dec. '21 | 0.05 |
| Tonopah-Belmont, s. g. | Nev. | 1,500,000 | 1 | .10 | 150,000 | 0.10 | 150,000 | 10,343,063 | Apr. '21 | 0.05 |
| Tonopah Extension, g. s. | Nev. | 1,282,801 | 1 | .15 | 192,420 | 0.20 | 258,544 | 2,812,364 | Dec. '21 | 0.05 |
| Tonopah Mining, g. s. | Nev. | 1,000,000 | 1 | .05 | 50,000 | 0.10 | 100,000 | 15,025,000 | Oct. '21 | 0.05 |
| United Eastern, g. | Ariz. | 1,363,000 | 1 | 0.72 | 981,360 | 0.60 | 817,800 | 3,952,700 | Oct. '21 | 0.15 |
| U. S. Sm., Ref. & Min. | U. S.-Mex. | 351,115 | 50 | 6.00 | 2,106,690 | 0.50 | 175,558 | 15,315,780 | Jan. '21 | 0.05 |
| U. S. Sm., Ref. & Min. pfd. | U. S.-Mex. | 486,350 | 50 | 3.50 | 1,702,225 | 3.50 | 1,702,225 | 26,553,492 | Oct. '21 | 0.875 |
| United Verde, c. | Ariz. | 300,000 | ..... | 6.00 | 1,800,000 | 6.00 | 1,800,000 | (Not reported) | Dec. '21 | 1.50 |
| United Verde Ext., c. | Ariz. | 1,050,000 | 0.50 | 2.00 | 2,100,000 | 1.00 | 1,050,000 | 12,705,000 | Nov. '21 | 0.25 |
| Utah Apex, c. | Utah | 528,200 | 5 | .25 | 132,050 | ..... | ..... | 132,050 | Nov. '20 | 0.25 |
| Utah Copper | Utah | 1,624,490 | 10 | 6.00 | 9,746,940 | 2.50 | 4,061,225 | 115,570,888 | Sept. '21 | 0.50 |
| Vanadian Corp. | Col. and Peru | 373,334 | ..... | 4.50 | 1,680,003 | 1.00 | 373,334 | 1,953,337 | Jan. '21 | 1.00 |
| Vindicator-Consol., g. | Col. | 1,500,000 | 1 | .01 | 15,000 | ..... | ..... | 3,847,500 | Jan. '20 | 0.01 |
| Wellington, g. | Col. | 1,000,000 | 1 | .10 | 100,000 | ..... | ..... | 2,050,000 | Sept. '20 | 0.10 |
| Wolverine, c. | Mich. | 60,000 | 25 | .50 | 30,000 | ..... | ..... | 10,350,000 | Jan. '20 | 0.50 |
| Yellow Pine, z. l.s. | Nev. | 1,000,000 | 1 | .06 | 60,000 | ..... | ..... | 2,596,008 | June '20 | 0.03 |
| **CANADIAN, MEXICAN, SOUTH AND CENTRAL AMERICAN MINING COMPANIES** | | | | | | | | | | |
| Alvarado, g. s. | Mex. | 350,000 | $20 | $1.50 | $52,500 | ..... | ..... | 52,000 | Oct. '20 | 0.50 |
| Amparo, g. s. | Mex. | 2,000,000 | 1 | .20 | 400,000 | 0.12 | 240,000 | 3,952,177 | Nov. '21 | 0.04 |
| Asbestos Corporation | Que. | 30,000 | 100 | 11.25 | 337,500 | 8.00 | 240,000 | 690,000 | Oct. '21 | 1.50 |
| Asbestos Corp'n pfd. | Que. | 40,000 | 100 | 13.00 | 520,000 | 9.00 | 360,000 | 1,360,000 | Oct. '21 | 1.75 |
| Beaver Cons., s. | Ont. | 2,000,000 | 1 | .03 | 60,000 | ..... | ..... | 710,000 | May '20 | 0.03 |
| Belmont Surf Inlet, g. | B. C. | 2,500,000 | 1 | .10 | 250,000 | 0.02½ | 62,500 | 562,500 | Jan. '21 | 0.025 |
| Cerro de Pasco, c. | Peru | 898,230 | ..... | 4.00 | 3,592,917 | 0.50 | 449,115 | 18,704,427 | Mar. '21 | 0.50 |
| Coniagas, s. | Ont. | 800,000 | 5 | .62½ | 500,000 | 0.125 | 100,000 | 10,250,000 | May '21 | 0.125 |
| Consol. M. & S. Canada | B. C. | 421,348 | 25 | 2.50 | 1,053,370 | ..... | ..... | 7,099,596 | Oct. '21 | 0.625 |
| Dome Mines | Ont. | 400,000 | 10 | 1.00 | 400,000 | 5.00 | 476,668 | 2,376,668 | Oct. '21 | 1.25 |
| El Oro M. & R. R., g. s. | Mex. | 1,147,500 | £1 | 1 sh. | £57,375 | 1 sh. | £57,375 | £2,070,500 | Nov. '21 | 1 sh. |
| Frontino & Bolivia, g. | Colombia | 140,000 | £1 | 2 sh. | £14,000 | ..... | ..... | ..... | July '20 | 1 sh. |
| Frontino & Bolivia pfd. | Colombia | 23,390 | £8½ | 5% | £10,000 | ..... | ..... | ..... | July '20 | 5% |
| Granby Consol., s. l. c. | B. C. | 150,000 | $100 | $1.25 | $187,500 | ..... | ..... | 10,526,885 | May '20 | 1.25 |
| Green Cananea, c. | Mex. | 500,000 | 100 | 1.00 | 500,000 | ..... | ..... | 17,097,165 | Nov. '20 | 0.50 |
| Hollinger Consol., g. | Ont. | 4,920,000 | 5 | .45 | 2,214,000 | 0.65 | 3,198,000 | 16,558,000 | Dec. '21 | 0.05 |
| Howe Sound, c. | B. C. | 1,984,150 | 1 | .20 | 396,830 | 0.05 | 99,208 | 1,190,490 | Jan. '21 | 0.05 |
| Kerr Lake | Ont. | 600,000 | 5 | .12½ | 75,000 | 0.50 | 300,000 | 685,000 | Oct. '21 | 0.125 |
| Lake Shore, g. | Ont. | 2,000,000 | 1 | .04 | 80,000 | 0.06 | 120,000 | 400,000 | Nov. '21 | 0.02 |
| Lucky Tiger-Comb., g. | Mex. | 715,337 | 10 | 1.85 | 1,323,373 | 1.06 | 758,257 | 8,227,830 | Dec. '21 | 0.14 |
| McIntyre Porcupine, s. | Ont. | 3,640,283 | 1 | .15 | 541,542 | 0.15 | 541,542 | 2,542,071 | Sept. '21 | 0.05 |
| McK.-Dar.-Sav., s. | Ont. | 2,247,692 | 1 | .12 | 269,724 | ..... | ..... | 5,955,382 | Oct. '20 | 0.03 |
| Mexico Mines of El Oro, g.s. | Mex. | 180,000 | £1 | 4 sh. | £36,000 | ..... | ..... | ..... | June '20 | 4 sh. |
| Min. Corp. of Can., s. | Ont. | 1,600,050 | $5 | $0.37½ | $622,519 | ..... | ..... | 5,498,875 | Sept. '20 | 0.125 |
| N. Y. & Hond. Ros., s. g. | C. A. | 200,000 | 10 | 1.60 | 320,000 | 0.30 | 60,000 | 5,270,000 | Jan. '21 | 0.30 |

(Continued on page 150)

CANADIAN, MEXICAN, SOUTH AND CENTRAL AMERICAN MINING COMPANIES—Continued

| Company Name | Situation | Shares Issued | Par Value | 1920 Per Share | 1920 Total | 1921 Per Share | 1921 Total | Total to Date | Latest Date | Latest Amount |
|---|---|---|---|---|---|---|---|---|---|---|
| Nipissing Mines, s. | Ont. | 1,200,000 | 5 | 1.50 | 1,800,000 | 0.95 | 1,140,000 | 23,280,000 | Oct. '21 | 0.15 |
| Ouro Preto Gold, pfd. | Brazil | 39,429 | £1 | 1 sh. | £2,418 | ..... | ..... | ..... | Sept. '21 | 2 sh. |
| Pato Mines, g. | Colombia | 100,000 | £1 | 21 sh. | £105,000 | 21 sh. | £105,000 | £260,000 | Dec. '21 | 7 sh. |
| St. John del Rey, g. | Brazil | 600,000 | £1 | 1/12 | £8,500 | 3d | £6,250 | ..... | July '21 | 6d. |
| St. John del Rey, pfd. | Brazil | 100,000 | £1 | 2 sh. | £16,000 | ..... | £5,000 | ..... | July '21 | 1 sh. |
| Santa Gertrudis, g. s. | Mex. | 1,500,000 | £1 | 2 sh. | £150,000 | ..... | ..... | £1,011,450 | July '20 | 1 sh. |
| Temiskaming, s. | Ont. | 2,500,000 | $1 | 0.016 | 40,000 | ..... | ..... | 2,175,000 | Jan. '20 | 0.016 |
| **HOLDING COMPANIES** | | | | | | | | | | |
| Exploration Co. | Mex. | 750,000 | 10 sh. | ..... | ..... | 1 sh. | £37,500 | £417,111 | Mar. '21 | 1 sh. |
| General Development | U. S. | 120,000 | $25 | 1.50 | 180,000 | ..... | ..... | 5,033,917 | Aug. '20 | 0.50 |
| St. Mary's Min. Land | Mich. | 160,000 | 25 | 2.00 | 320,000 | 1.00 | 160,000 | 12,480,000 | Dec. '21 | 1.00 |
| White Knob C. & D., pfd. | Cal. | 200,000 | 10 | .05 | 10,000 | .... | ..... | 360,000 | Feb. '20 | 0.05 |
| Yukon-Alaska Trust | ..... | 203,433 | ... | 1.00 | 203,433 | .... | ..... | 3,254,928 | Sept. '20 | 1.00 |

*a* Includes returned capital.

# Mining Stocks in 1921

| Stock | Exch. | High | | Low | | Last | Sales |
|---|---|---|---|---|---|---|---|
| **COPPER** | | | | | | | |
| Ahmeek | Boston | 63 | Dec. 15 | 40 | Aug. 22 | 62½ | 9,455 |
| Alaska-B.C.,new | N. Y. Curb | 3⅝ | Nov. | 0.29 | Aug. (old) | 2⅝ | 27,950 |
| Allouez | Boston | 24½ | Nov. 14 | 16 | Apr. 5 | 24 | 5,698 |
| Anaconda | New York | 50⅜ | Dec. 27 | 31¾ | Aug. 25 | 49⅝ | 898,500 |
| Arcadian Consol | Boston | 3¾ | Jan. 6 | 1⅛ | Sept. 21 | 3 | 32,928 |
| Ariz. Com'l | Boston | 10 | Apr. 28 | 6⅞ | Jan. 3 | 9 | 22,008 |
| Big Ledge | N. Y. Curb | 0.44 | Oct. | 0.13 | July | 0.25 | 1,474,925 |
| Bingham Mines | Boston | 14 | Oct. 6 | 8 | Mar. 8 | 12⅝ | 23,267 |
| Calumet & Ariz. | Boston | 60 | Dec. 15 | 40½ | Jan. 3 | 59 | 35,020 |
| Calumet & Hecla | Boston | 280 | Dec. 16 | 210 | Apr. 5 | 272 | 6,356 |
| Canada Copper | N. Y. Curb | 0.42 | Dec. | 0.14 | July | 0.38 | 224,151 |
| Centennial | Boston | 10 | Jan. 28 | 7 | Jan. 4 | 9⅜ | 4,093 |
| Cerro de Pasco | New York | 36½ | Dec. 12 | 23 | Mar. 10 | 34⅜ | 286,105 |
| Chile Copper | New York | 16⅞ | Dec. 15 | 9 | Mar. 9 | 15¼ | 736,900 |
| Chino | New York | 29½ | Dec. 15 | 19½ | Mar. 20 | 28 | 265,600 |
| Columbus Rexall | Salt Lake | 0.42 | ..... | 0.10½ | Dec. 3 | 0.10½ | ..... |
| Con. Arizona | N. Y. Curb | 0.18 | Nov. | 0.01 | June | 0.03 | 48,200 |
| Con. Copper M. | N. Y. Curb | 2½ | Jan. | 0.83 | Aug. | 1⅞ | 123,744 |
| Copper Range | Boston | 40⅜ | Dec. 16 | 27 | Jan. 3 | 38⅜ | 47,052 |
| Crystal Copper | Boston Crb | 0.65 | Dec. | 0.20 | Oct. | 0.64 | ..... |
| Davis-Daly | Boston | 7½ | Jan. 6 | 5 | Mar. 28 | 6½ | 58,095 |
| East Butte | Boston | 11⅜ | Dec. 16 | 7 | Aug. 23 | 11½ | 55,153 |
| First National | Boston Crb | 1 1/16 | Jan. | 0.50 | June | 0.75 | ..... |
| Franklin | Boston | 3½ | Jan. 6 | 1⅜ | Apr. 2 | 1⅞ | 14,859 |
| Gadsden Copper | Boston Crb | 0.65 | Jan. | 0.38 | Aug. | 0.50 | ..... |
| Granby Consol. | New York | 34½ | Nov. 25 | 15 | Aug. 16 | 28½ | 40,250 |
| Phelps Dodge | Open Mar. | 185 | Nov. | 125 | Mar. | 180 | ..... |
| Quincy | Boston | 46 | Dec. 9 | 33½ | Aug. 25 | 43 | 8,178 |
| Ray Consol. | New York | 16 | Dec. 15 | 11 | Mar. 12 | 15⅛ | 272,150 |
| Ray Hercules | N. Y. Curb | 0.75 | Feb. | 0.12 | Dec. | 0.12 | 293,220 |
| St. Mary's M. L. | Boston | 45 | Dec. 15 | 28 | Jan. 3 | 43 | 9,475 |
| Seneca Copper | Boston | 24½ | Nov. 22 | 12⅜ | Mar. 11 | 22⅜ | 4,960 |
| Shannon | Boston | 1⅛ | Dec. 1 | ⅛ | Jan. 3 | 1 | 18,975 |
| Shattuck Ariz. | New York | 9⅜ | Dec. 16 | 4⅞ | Jan. 3 | 8½ | 34,900 |
| South Lake | Boston | 2 | Jan. 18 | 0.35 | Nov. 17 | 0.62 | 4,445 |
| Superior & Bost. | Boston | 2¼ | Feb. 17 | 1 | June 23 | 1⅜ | 60,780 |
| Tenn. C.&C. cfs. | New York | 11 | Dec. 12 | 6⅜ | Aug. 26 | 10 | 193,350 |
| Tuolumne | Boston | 0.85 | Dec. 2 | 0.34 | Aug. 19 | 0.75 | 108,510 |
| United Verde Ex | Boston Curb | 30 | Dec. | 20 | Aug. | 29¼ | ..... |
| Utah Consol. | Boston | 5 | Jan. 12 | 1¼ | Nov. 16 | 1½ | 21,738 |
| Utah Copper | New York | 66⅜ | Dec. 15 | 41½ | Aug. 25 | 63⅜ | 801,900 |
| Utah Metal & T. | Boston | 2 1/16 | Jan. 31 | 0.95 | Jan. 4 | 1⅜ | 112,462 |
| Victoria | Boston | 2½ | Feb. 17 | 0.40 | May 4 | 1½ | 14,020 |
| Winona | Boston | 0.80 | Mar. 4 | 0.35 | Jan. 6 | 0.35 | 11,683 |
| Wolverine | Boston | 14 | Feb. 21 | 8½ | July 5 | 11 | 6,948 |
| **NICKEL-COPPER** | | | | | | | |
| Internat. Nickel | New York | 17 | May 2 | 11½ | Aug. 24 | 12 | 537,970 |
| Int. Nickel, pf | New York | 85 | May 4 | 60 | Dec. 30 | 65 | 6,955 |
| **LEAD** | | | | | | | |
| National Lead | New York | 87 | Dec. 13 | 67¾ | July 28 | 87 | 64,950 |
| Natl. Lead, pfd | New York | 108 | May 4 | 100 | June 20 | 108 | 9,250 |
| St. Joseph Lead | New York | 14¼ | Dec. 2 | 10½ | Aug. 26 | 12⅞ | 28,903 |
| **QUICKSILVER** | | | | | | | |
| New Idria | Boston | 2 | Dec. 17 | 0.40 | Nov. 22 | 1 | 2,920 |
| **ZINC** | | | | | | | |
| Am. Z. L. & S. | New York | 14⅜ | Dec. 15 | 6¾ | Sept. 1 | 13¼ | 64,150 |
| Am.Z.L.&S. pfd. | New York | 40⅞ | Dec. 16 | 22⅞ | Aug. 22 | 36 | 21,800 |
| Butte C. & Z. | New York | 6¼ | Dec. 13 | 3⅛ | Aug. 24 | 5⅜ | 126,800 |
| Butte & Superior | New York | 22 | Dec. 16 | 10⅛ | June 20 | 22 | 126,900 |
| Callahan Zn-Ld. | New York | 7⅛ | Jan. 8 | 3¼ | Aug. 25 | 5⅜ | 336,900 |
| New Jersey Zn. | N. Y. Curb | 158 | Jan. | 110 | July | 125 | 3,763 |
| Yellow Pine | Los Angeles | 0.60 | Jan. | 0.35 | Nov. | 0.47 | ..... |
| **GOLD** | | | | | | | |
| Alaska Gold | New York | 1⅛ | Feb. 9 | 1/4 | Dec. 14 | 1/4 | 137,600 |
| Alaska Juneau | New York | 1⅜ | Feb. 9 | 1/3 | Oct. 31 | 1/3 | 231,600 |
| Carson Hill | New York | 15½ | Nov. 28 | 11/16 | Dec. 22 | 11/16 | 13,100 |
| Cresson Cons. G. | N. Y. Curb | 2⅜ | Nov. | 1/2 | Jan. | 2⅜ | 1,881,500 |
| Dome Extension | Toronto | 0.80½ | May | 0.38 | Jan. | 0.71 | 20,848 |
| Dome Mines | New York | 21⅜ | Apr. 21 | 10⅛ | Jan. 3 | 19 | 236,400 |
| Florence Goldfld | N. Y. Curb | 0.50 | Sept. | 0.12 | Jan. | 0.26 | 2,413,800 |
| Golden Cycle | Colo. Spgs. | 0.80¼ | Dec. | 0.53 | Mar. | 0.62¼ | ..... |
| Goldfield Consol. | N. Y. Curb | 0.11 | Feb. | 0.03 | Oct. | 0.04 | 594,864 |
| Hollinger Consol. | Toronto | 7.95 | Nov. | 5.55 | Jan. | 7.74 | 237,271 |
| Homestake Min. | New York | 61 | May 13 | 49½ | Mar. 2 | 55 | 18,600 |
| Kirkland Lake | Toronto | 0.56 | Feb. | 0.26½ | Nov. | 0.27 | 377,125 |
| Lake Shore | Toronto | 1.43 | May | 1.03 | Jan. | 1.25 | 216,760 |
| McIntyre-Porcu. | Toronto | 2.16 | Apr. | 1.80 | Jan. | 2.11 | 486,161 |
| Porcu. Crown | Toronto | 0.29 | Apr. | 0.10 | Oct. | 0.10⅝ | 463,303 |
| Porcu.V.N.T. | Toronto | 0.24 | May | 0.14 | Apr. | 0.17½ | 1,320,447 |
| Portland | Colo. Sprgs. | 0.63 | May | 0.33 | Nov. | 0.40 | ..... |
| Schumacher | Toronto | 0.35 | Feb. | 0.17½ | Jan. | 0.31 | 442,650 |
| Silver Pick | N. Y. Curb | 0.50 | Dec. | 0.03 | Apr. | 0.50 | 408,536 |
| Teck Hughes | Toronto | 0.18½ | Apr. | 0.09 | Jan. | 0.15¼ | 1,124,450 |
| Tom Reed | Los Angees | 1.40 | Feb. | 0.32 | Oct. | 0.38 | ..... |
| United Eastern | N. Y. Curb | 3 | Mar. | 2 1/16 | Aug. | 2 7/16 | 617,431 |
| Vindicator Cons. | Colo. Sprgs. | 0.39 | June | 0.17 | Feb. | 0.22½ | ..... |
| White Caps Min. | N. Y. Curb | 0.10 | Jan. | 0.02 | Sept. | 0.05 | 541,845 |
| Yukon Gold | N. Y. Curb | 1⅜ | Oct. | ¾ | Apr. | 1 1/16 | 111,423 |
| **SILVER** | | | | | | | |
| Batopilas Min. | New York | 1 | Jan. 10 | ½ | Aug. 8 | ½ | 15,150 |
| Beaver Consol. | Toronto | 0.41 | Feb. | 0.16¾ | Dec. | 0.18 | 377,037 |
| **SILVER** | | | | | | | |
| Coniagas | Toronto | 2.10 | Mar. | 1.14 | Nov. | 1.50 | 16,027 |
| Crown Reserve | Toronto | 0.20 | Feb. | 0.07½ | July | 0.08 | 230,119 |
| Kerr Lake | N. Y. Curb | 3⅜ | Aug. | 2 | May | 3⅜ | 365,400 |
| La Rose | Toronto | 0.38 | Oct. | 0.16½ | June | 0.33 | 207,725 |
| McKinley-Dar. | Toronto | 0.31½ | Jan. | 0.14 | July | 0.14 | 111,745 |
| Min. Corp. Can. | Toronto | 1.26 | June | 0.80 | May | 1.15 | 56,406 |
| Nipissing | N.Y. Curb | 8¼ | Jan. | 4 | July | 6⅜ | 110,780 |
| Ontario Silver | New York | 6 | May 9 | 3½ | Aug. 23 | 4 | 19,950 |
| Ophir Silver | N. Y. Curb | 0.25 | May | 0.11 | Oct. | 0.12 | 28,765 |
| Temiskaming | Toronto | 0.28 | Aug. | 0.17½ | May | 0.25 | 155,080 |
| Trethewey | Toronto | 0.21 | Apr. | 0.05¼ | Dec. | 0.05¾ | 632,604 |
| **GOLD AND SILVER** | | | | | | | |
| Boston & Mont. | N. Y. Curb | 1⅜ | Oct. | 0.37 | Jan. | 0.87 | 10,037,235 |
| Cash Boy | N. Y. Curb | 0.09 | Jan. | 0.03 | Sept. | 0.05 | 806,350 |
| Greene-Cananea | New York | 29½ | Dec. 15 | 18½ | Mar. 11 | 27¾ | 42,800 |
| Hancock | Boston | 3½ | Jan. 6 | 1½ | Sept. 7 | 2 | 3,757 |
| Howe Sound | N. Y. Curb | 3½ | Jan. | 1⅞ | May | 2⅜ | 57,250 |
| Inspiration Cons | New York | 42¼ | Dec. 16 | 29⅝ | Mar. 12 | 40¼ | 636,100 |
| Iron Cap | Boston Crb | 9½ | Jan. | 4½ | June | 7⅜ | ..... |
| Isle Royale | Boston | 24½ | Dec. 16 | 16¼ | Jan. 3 | 23½ | 11,675 |
| Kennecott | New York | 27⅛ | Dec. 27 | 16 | Mar. 11 | 26⅜ | 613,300 |
| Keweenaw | Boston | 2 | Dec. 15 | 0.98 | Sept. 20 | 1⅛ | 10,040 |
| Lake Copper | Boston | 3½ | Dec. 15 | 2 | Jan. 4 | 2⅜ | 8,556 |
| La Salle | Boston | 2¼ | Feb. 11 | 1¼ | Jan. 25 | 1⅜ | 11,852 |
| Magma Chief | N. Y. Curb | 0.21 | Jan. | 0.03 | Sept. | 0.08 | 20,500 |
| Magma Copper | N. Y. Curb | 0.28 | Dec. | 0.17 | Mar. | 0.28 | 72,610 |
| Majestic | Boston Crb | 0.15 | Feb. | 0.02 | Dec. | 0.04 | ..... |
| Mason Valley | Boston | 2 | Sept. 13 | 1¼ | Jan. 22 | 1⅜ | 7,495 |
| Mass Consol. | Boston | 3⅜ | Jan. 8 | 0.55 | Apr. 9 | 2⅛ | 18,361 |
| Miami Copper | New York | 28 | Dec. 16 | 15¾ | Jan. 3 | 27⅜ | 177,650 |
| Michigan | Boston | 3½ | May 5 | 1¼ | Aug. 4 | 2 | 4,070 |
| Mohawk | Boston | 59 | Dec. 15 | 43½ | Jan. 3 | 55⅛ | 15,469 |
| Mother Lode Co | N. Y. Curb | 7⅜ | Dec. | 3½ | July | 7½ | 221,615 |
| Nevada Consol. | New York | 15⅝ | Dec. 12 | 9 | Mar. 31 | 14⅜ | 199,900 |
| New Cornelia | Boston | 18½ | Dec. 16 | 12½ | Sept. 2 | 18 | 47,542 |
| North Butte | Boston | 14½ | Dec. 15 | 8 | Mar. 23 | 13 | 102,289 |
| North Lake | Boston | 0.50 | Jan. 7 | 12 | Nov. 17 | 0.20 | 5,988 |
| Ohio Copper | N. Y. Curb | 0.13 | Dec. | 0.05 | Oct. | 0.08 | 73,700 |
| Old Dominion | Boston | 25⅜ | Nov. 22 | 15¾ | Jan. 3 | 23 | 21,005 |
| Osceola | Boston | 35½ | Dec. 16 | 21 | Aug. 10 | 32 | 8,063 |
| Dolores Esper'za | N. Y. Curb | 2½ | July | 0.75 | Dec. | 1 | 19,950 |
| El Salvador | N. Y. Curb | 0.56 | Jan. | 0.03 | Dec. | 0.04 | 1,621,010 |
| Jim Butler | N. Y. Curb | 0.19 | Feb. | 0.05 | Dec. | 0.06 | 433,300 |
| Jumbo Extens. | N. Y. Curb | 0.12 | Feb. | 0.01 | Dec. | 0.03 | 545,100 |
| Louisiana Con. | N. Y. Curb | ¼ | Jan. | ¼ | Jan. | ¼ | 6,000 |
| MacNamara M. | N. Y. Curb | 0.31 | May | 0.04 | Dec. | 0.08 | 1,015,500 |
| Tonopah-Belm't | N. Y. Curb | 1⅛ | Feb. | 0.98 | July | 1⅛ | 173,550 |
| Tonopah-Divide | N. Y. Curb | 1⅜ | Jan. | 0.54 | Sept. | 0.65 | 931,897 |
| Tonopah-Exten. | N. Y. Curb | 1⅜ | Jan. | 1⅛ | Apr. | 1 1/16 | 172,875 |
| Tonopah Mining | N. Y. Curb | 1⅛ | Mar. | 1 1/16 | May | 1⅜ | 63,745 |
| West End Cons. | N. Y. Curb | 1 1/16 | May | 0.65 | Aug. | 0.75 | 197,565 |
| **SILVER-LEAD** | | | | | | | |
| Caledonia | N. Y. Curb | 0.17 | Jan. | 0.05 | Dec. | 0.06 | 659,800 |
| Cardiff M. & M. | Salt Lake | 1.22½ | July | 0.82 | Nov. | 0.92 | ..... |
| Chief Consol. | Boston Crb | 3⅜ | Oct. | 2½ | Aug. | 3 | ..... |
| Consol. M. & S. | Montreal | 21 | Jan. | 12½ | June | 18 | 27,149 |
| Daly Mining | Salt Lake | 2.50 | ..... | 1.50 | ..... | ..... | ..... |
| Daly-West | Boston | 4¼ | Jan. 18 | 1⅜ | Nov. 16 | 1⅞ | 4,683 |
| Eagle & Bl. Bell. | Boston Crb | 3 | Sept. | 1⅜ | Jan. | 2½ | ..... |
| Electric Point | Spokane | 0.08½ | Feb. | 0.03 | July | 0.04 | ..... |
| Federal M. & S. | New York | 13⅜ | Dec. 13 | 5½ | June 20 | 10 | 3,960 |
| Fed. M. & S., pfd | New York | 43⅜ | Dec. 14 | 21 | Aug. 30 | 39 | 28,570 |
| Florence Silver | Spokane | 0.19½ | Dec. | 0.02¼ | Nov. | 0.19½ | ..... |
| Grand Central | Salt Lake | ..... | ..... | ..... | ..... | 0.41 | ..... |
| Hecla Mining | N. Y. Curb | 4⅜ | Nov. | 3⅜ | Mar. | 4⅜ | 131,680 |
| Iron Blossom Cn | N. Y. Curb | 0.53 | Dec. | 0.12 | Mar. | 0.30 | 246,470 |
| Judge M. & S. | Salt Lake | 3 | ..... | 2.40 | Dec. 10 | 2.50 | ..... |
| Marsh Mines | N. Y. Curb | 0.11 | May | 0.03 | Aug. | 0.04 | 667,080 |
| Prince Consol. | Salt Lake | 0.38 | Feb. | 0.05 | Nov. | 0.07½ | ..... |
| Rambler-Cariboo | Spokane | ..... | ..... | ..... | ..... | .04 | ..... |
| Rex Consol. | N. Y. Curb | 0.14 | May | 0.04 | Jan. | 0.07 | 1,222,830 |
| South Hecla | Salt Lake | 1.15 | ..... | 0.20½ | ..... | ..... | ..... |
| Std. Silver-Ld. | N. Y. Curb | 0.18 | Jan. | 0.08 | Sept. | 0.10 | 122,050 |
| Stewart Mining | N. Y. Curb | 0.11 | Feb. | 0.01 | Dec. | 0.01 | 165,400 |
| Tamarack-Custer | Spokane | ..... | ..... | ..... | ..... | 2.22 | ..... |
| Tintic Standard | Salt Lake | 3.42½ | ..... | 1.60 | ..... | 1.80 | ..... |
| Utah Apex | Boston | 3½ | Oct. 7 | 1⅜ | Aug. 16 | 3 | 40,833 |
| Wilbert Mining | N. Y. Curb | 0.04½ | May | 0.01 | Jan. | 0.01 | 879,740 |
| **VANADIUM** | | | | | | | |
| Vanadium Corp. | New York | 41 | Jan. 11 | 25⅛ | June 21 | 31⅞ | 912,700 |
| **ASBESTOS** | | | | | | | |
| Asbestos Corp. | Montreal | 82½ | Jan. | 36 | Aug. | 48½ | 15,679 |
| Asbestos C., pf. | Montreal | 95 | Jan. | 65 | Sept. | 75½ | 6,380 |
| **SULPHUR** | | | | | | | |
| Freeport Texas | New York | 20¼ | Jan. 17 | 9¼ | Aug. 24 | 13⅞ | 146,700 |
| Texas Gulf | New York | 42 | Dec. 28 | 32½ | Dec. 1 | 41 | 155,150 |
| **MINING, SMELTING AND REFINING** | | | | | | | |
| Am. Sm. & Ref. | New York | 47½ | Dec. 12 | 29⅝ | Aug. 25 | 45½ | 526,600 |
| Am. S. & R. pf. | New York | 90 | Dec. 12 | 63¼ | Aug. 26 | 86½ | 64,100 |
| Am.Sm.Sec.pf.A. | New York | 88 | Dec. 2 | 63 | Jan. 11 | 87½ | 30,715 |
| U.S. Sm. R.&M. | New York | 39¾ | Dec. 14 | 26 | Apr. 1 | 36 | 54,650 |
| U.S.Sm.R&M.pf | New York | 45 | Dec. 28 | 37 | Aug. 9 | 45 | 9,100 |

# THE MARKET REPORT

## Daily Prices of Metals

| Jan. | Copper, N. Y., net refinery* | Tin | | Lead | | Zinc |
|---|---|---|---|---|---|---|
| | Electrolytic | 99 Per Cent | Straits | N. Y. | St. L. | St. L. |
| 12 | 13.50 | 32.375 | 33.125 | 4.70 | 4.375@4.40 | 4.75 |
| 13 | 13.50 | 32.375 | 33.00 | 4.70 | 4.375@4.40 | 4.75 |
| 14 | 13.50 | 32.375 | 33.00 | 4.70 | 4.375@4.40 | 4.75 |
| 16 | 13.50 | 31.875 | 32.50 | 4.70 | 4.375@4.40 | 4.725 |
| 17 | 13.50 | 31.50 | 32.125 | 4.70 | 4.375@4.40 | 4.725 |
| 18 | 13.50 | 31.75 | 32.25 | 4.70 | 4.375@4.40 | 4.70@4.725 |

*These prices correspond to the following quotations for copper delivered: Jan. 12 to 18 inc., 13.75c.

The above quotations are our appraisal of the average of the major markets based generally on sales as made and reported by producers and agencies, and represent to the best of our judgment the prevailing values of the metals for deliveries constituting the major markets, reduced to the basis of New York, cash, except where St. Louis is the normal basing point, or as otherwise noted. All prices are in cents per pound. Copper is commonly sold "delivered," which means that the seller pays the freight from the refinery to the buyer's destination.

Quotations for copper are for ordinary forms of wire bars, ingot bars and cakes. For ingots an extra of 0.05c. per lb. is charged and there are other extras for other shapes. Cathodes are sold at a discount of 0.125c. per lb.

Quotations for zinc are for ordinary Prime Western brands. Tin is quoted on the basis of spot American tin, 99 per cent grade, and spot Straits tin.

## London

| Jan. | Copper | | | Tin | | Lead | | Zinc | |
|---|---|---|---|---|---|---|---|---|---|
| | Standard | | Electrolytic | | | | | | |
| | Spot | 3 M | | Spot | 3 M | Spot | 3 M | Spot | 3 M |
| 12 | 65⅜ | 66¼ | 73 | 167¼ | 168¾ | 24¼ | 24 | 26½ | 26⅞ |
| 13 | 65½ | 66¼ | 73 | 166¼ | 168 | 24⅛ | 24 | 26⅜ | 27 |
| 14 | .. | .. | ... | .... | .... | ... | ... | ... | ... |
| 16 | 65⅝ | 66⅜ | 73 | 165 | 166¾ | 23⅞ | 24 | 26½ | 26⅞ |
| 17 | 65⅛ | 65⅞ | 72½ | 163⅜ | 165 | 23⅛ | 23⅛ | 26⅜ | 26½ |
| 18 | 64½ | 65⅜ | 72 | 163⅞ | 165¾ | 23⅛ | 23⅛ | 26⅜ | 26¾ |

The above table gives the closing quotations on the London Metal Exchange. All prices in pounds sterling per ton of 2,240 lb.

## Silver and Sterling Exchange

| Jan. | Sterling Exchange "Checks" | Silver | | | Jan. | Sterling Exchange "Checks" | Silver | | |
|---|---|---|---|---|---|---|---|---|---|
| | | New York Domestic Origin | New York Foreign Origin | London | | | New York Domestic Origin | New York Foreign Origin | London |
| 12 | 422½ | 99⅝ | 65¾ | 35⅛ | 16 | 422¼ | 99⅝ | 65⅞ | 35⅛ |
| 13 | 422 | 99⅝ | 66¼ | 35⅜ | 17 | 422¼ | 99⅝ | 65¾ | 35 |
| 14 | 422 | 99⅝ | 66⅛ | 35⅜ | 18 | 421¾ | 99⅝ | 65⅞ | 35⅛ |

New York quotations are as reported by Handy & Harman and are in cents per troy ounce of bar silver, 999 fine. London quotations are in pence per troy ounce of sterling silver, 925 fine. Sterling quotations represent the demand market in the forenoon. Cables command one-half cent premium.

## Metal Markets

### New York, Jan. 18, 1922

Business continues poor in the metal markets, with few price changes. In fact, the only changes of importance occur among the minor metals, platinum showing a sharp advance, and bismuth, the price of which is fixed in London over long periods, being revised from 7s. 6d. to 9s.

### Copper

Producers have done less business than last week, and the outside market continues extremely quiet. The large interests report small domestic sales at 14c. delivered, but it is difficult to understand why any consumer should pay this price except where delivery charges are extremely high or where other considerations are involved. Some of the smaller producers have sold lots of a few hundred tons for first-quarter delivery at 13.75c. delivered, during the week, and were ready to supply larger amounts at the same figure. Large tonnages could also be obtained for second- and third-quarter delivery at this price. Some small lots of prompt copper were obtainable in the outside market at 13.625c.

The statistical position of copper is continuing to improve, and higher prices are likely as soon as buying is again on the scale of the closing months of 1921. The increase in production which will take place with the resumption of mining by the large companies will no doubt act as a brake on price advances during the closing half of the year, however.

Export demand has been quiet, with moderate orders from the Continent and from Japan. The European business through the Export Association has in general been booked to net producers here slightly less than 14c. per lb. Outside interests have not been able to do quite so well on export business.

### Lead

The official contract price of the American Smelting & Refining Co. remains at 4.70c.

Lead has been in about the usual demand at practically unchanged prices. A scarcity of some grades exists in the East, and some producers are off the market or are quoting 4.75 or 4.80c. to discourage most of the business. All of the Mexican lead continues to go abroad, but with the fall in London yesterday, so far unaccounted for, there is no immediate probability of sales of domestic lead for export. Common lead continues in free supply in the St. Louis district. One or two interests are quoting 4.375c. and have done rather a good business at that level. Others are selling at 4.40c., and still others are quoting 4.425c., but so far as we are advised have made no sales. Desilverized and corroding grades have been in demand at 10 to 15 points' premium; orders for these grades in Cincinnati were booked by more than one interest during the week at 4.75c. Forward lead is not being traded in to any extent, but would no doubt command a slight premium.

### Zinc

Zinc has continued the weakness shown last week, and the market has declined a few points further. A small tonnage has been sold as low as 4.70c., but at this level few producers are willing to enter the market. The price of Joplin ore is still too high to make any profit with present metal prices. Inquiries have been smaller in number, and larger producers are only satisfying the requirements of regular customers. High-grade zinc continues to be sold in fair volume at 6c., with freight allowed.

### Tin

Demand for tin from consuming interests has been quite active during the last few days, the tin-plate orders from the Standard Oil Co., California packers, and others having had their effect. Formerly all the tin-plate manufacturers purchased their tin supplies several months ahead, but owing to the disorganized state of the market in recent months, one of the largest concerns is now buying only from hand to mouth; others have followed. This has re-

sulted in an extraordinary demand for spot tin, which as a result now commands a slight premium. One boat bringing around 2,000 tons to this port has been compelled to put in at Alexandria, Egypt, as a result of a broken shaft, which will add to the scarcity at the end of the month. Electrolytic is in limited supply at approximately the same prices as Straits.

Straits tin for forward delivery: Jan. 12th, 32.75@33.00c.; 13th, 32.50@32.75c.; 14th, 32.50@32.75c.; 16th, 32.00@32.25c.; 17th, 31.75@32.00c.; 18th, 31.75@32.00c.

Arrivals of tin, in long tons: Jan. 10th, Straits, 35; London, 800; 13th, Straits, 500; 16th, Straits, 110; China, 15.

## Gold

Gold in London: Jan. 12th, 97s. 3d.; 13th, 97s. 4d.; 16th, 97s. 6d.; 17th, 97s. 7d.; 18th, 97s. 11d.

## Foreign Exchange

The foreign exchange market has been quiet during the last few days. A slight reaction in most quotations occurred yesterday. On Tuesday, Jan. 17, francs were 8.14c.; lire, 4.3575c.; and marks, 0.525c. New York funds in Montreal, 6 5/16 per cent premium.

## Silver

The market has continued dull, with limited buying for prompt New York and San Francisco delivery at about the London parity, and any material increase in the demand for silver seems unlikely until after the settlement period of the Chinese New Year.

**Mexican Dollars**—Jan. 12th, 50; 13th, 50¼; 14th, 50; 16th, 50; 17th, 50; 18th, 50.

## Other Metals

Quotations cover wholesale lots unless otherwise specified.

**Aluminum—20c. per lb. for 99 per cent grade; 19c. for 98@99 per cent; 18c. for 94@98 per cent. Outside market nominal at 17@18c. for 98@99 per cent virgin grades.**

**Antimony**—Chinese and Japanese brands, 4.375@4.50c.; W. C. C. brand, 5.25@5.75c. per lb. Cookson's "C" grade, spot, 9c. per lb. Chinese needle antimony, lump, nominal at 4c. per lb. Standard powdered needle antimony (200 mesh), nominal at 5.25c. per lb.

White antimony oxide, Chinese, guaranteed 99 per cent $Sb_2O_3$, wholesale lots, 6½@7c.

**Arsenic**—7½c. per lb.

**Bismuth**—The London price increased on Jan. 17 from 7s. 6d. to 9s., which has occasioned an advance in the New York market to $1.85@$1.95 per lb.

**Cadmium**—$1@$1.10 per lb. in 1,000-lb. lots. Smaller quantities, $1.10@$1.25 per lb. Demand is somewhat improved.

**Platinum**—$93@$105 per oz. Rise attributed to scarcity of spot supplies and their close control. Considerable amounts of metal have been bought on the rise. Consuming demand has tapered off. Jewelers are not viewing the sudden rise with joy.

**Palladium**—$60@$65 per oz. Has risen in sympathy with platinum.

**Iridium**—$170@$200 per oz.

**Quicksilver**—$50@$52 per 75-lb. flask. San Francisco wires $48.70.

The prices of the following metals remain unchanged from the figures published in these columns on Jan. 7: Cobalt, Molybdenum, Monel Metal, Nickel, Osmium, Rhodium, Selenium, Thallium and Tungsten.

## Metallic Ores

**The market is generally exceedingly quiet, and prices on the following ores remain unchanged from the figures published in the Market Report in the** Jan. 7 issue: Chrome, Iron, Magnetite, Manganese, Molybdenum, Tantalum, Titanium, Tungsten, Uranium, Vanadium, Zircon, and Zirkite ores.

## Zinc and Lead Ore Markets

**Joplin, Mo., Jan. 14**—Zinc blende, per ton, high, $31.10; Basis 60 per cent zinc, premium, $28; Prime Western, $27@$26; fines and slimes, $25@$24; average settling price, all grades of zinc, $29.38.

Lead, high, $62.50; basis 80 per cent lead, $60; average settling price, all grades of lead, $59.80 per ton.

Shipments for the week: Blende, 5,207; lead, 917 tons. Value, all ores the week, $207,960.

Shipping is partially held up awaiting the freight rate reduction promised to be effective on the 20th. Still only about 10,000 tons is sold ahead of delivery. The purchase this week was practically the same as the shipment, showing only an excess of 70 tons.

Buyers cut prices generally $1 per ton on virtually all grades, in the purchases this week for future delivery. Some buyers had orders not to exceed a $26 basis Prime Western, but about an equal tonnage was purchased on $27 basis. The weakness of slab zinc is given as a reason for lowering prices.

**Platteville, Wis., Jan. 14**—Blende, basis 60 per cent zinc, $30. Lead ore, basis 80 per cent lead, $60 per ton. Shipments for the week: Blende, 376 tons. Shipments for the year: Blende, 746 tons. Shipped during the week to separating plants, 821 tons blende.

## Non-Metallic Minerals

**Generally dull markets exist for the non-metallic minerals, and there is no quotable change in the following** from the prices published in our Jan. 7 issue: Asbestos, Barytes, Bauxite, Borax, Chalk, China Clay, Emery, Feldspar, Fluorspar, Fuller's Earth, Graphite, Gypsum, Kaolin, Limestone, Magnesite, Mica, Monazite, Phosphate Rock, Pumice Stone, Pyrites, Silica, Sulphur and Talc.

## Mineral Products

**Sodium Sulphate — For 95 per cent material, $12.50 per ton, f.o.b. in bulk, Western mines, spot and six months' contract; $18@$21 per ton, New York.**

Prices of Copper Sulphate, Potassium Sulphate and Sodium Nitrate are unchanged from the quotations published Jan. 7.

## Ferro-Alloys

**Ferrochrome—Carload lots, spot and contract, 60 to 70 per cent chromium, 6 to 8 per cent carbon, 11½c. per lb. of chromium contained; 4 to 6 per cent carbon, 12c., f.o.b. works.**

**No quotable changes have taken place in the following ferro-alloys from the** prices quoted in the Jan. 7 issue: Ferrotitanium, Ferrocerium, Ferromanganese, Ferromolybdenum, Ferrosilicon, Ferrotungsten, Ferro-Uranium and Ferrovanadium.

## Metal Products

**Nickel Silver**—27.75c. per lb. for 18 per cent nickel, grade "A" sheets.

**Prices of Copper Sheets, Lead Sheets,** Yellow Metal, and Zinc Sheets are unchanged from the quotations published on Jan. 7.

## Refractories

**Prices on the following are unchanged from the figures published in** the Jan. 7 issue: Bauxite Brick, Chrome Brick, Chrome Cement, Firebrick, Magnesite Brick and Silica Brick.

## The Iron Trade

**Pittsburgh, Jan. 17, 1922**

Steel mill operations are gradually increasing, after the curtailment in the last two weeks of December, and operations are likely to be at as high a rate by Feb. 1 as on Dec. 1, with an ingot production rate of 22,000,000 or 23,000,000 tons a year.

Buying of steel is increasing and is marked by the smallness of individual orders and the mixed character of specifications. Probabilities are that buyers will be disposed in the next few weeks to begin replenishing stocks.

Finished-steel prices are now steady. There has been no decline in any important steel product in four weeks, and concessions from regular prices, for large orders, are small or absent entirely. Sheets are rigidly maintained at full asking prices, 3c. on black and 4c. on galvanized. Bars, shapes, and plates are 1.50c., with concessions infrequent. In the South and West, departures from Pittsburgh basing are common with many products, owing to local competition.

**Iron Ore**—Prices of Lake Superior iron ore at Lake Erie dock will be down 50c. to $1 a ton for the 1922 season, depending largely on adjustments in the rail freights, mine to lake, and the vessel rate. For 1921 there was a reduction of $1, making Mesabi non-bessemer $5.55.

**Pig Iron**—The market remains inactive, prices being quotable at $19.50 for bessemer, $18.25 for basic, and $19.50 for foundry, f.o.b. Valley furnaces, freight to Pittsburgh being $1.96.

## Coke

**Connellsville — Furnace, $2.75@$3; foundry, $3.75@$4.50.**